TECHNOLOGY DEPT.

May 1941

TECHNOLOGY REVIEW

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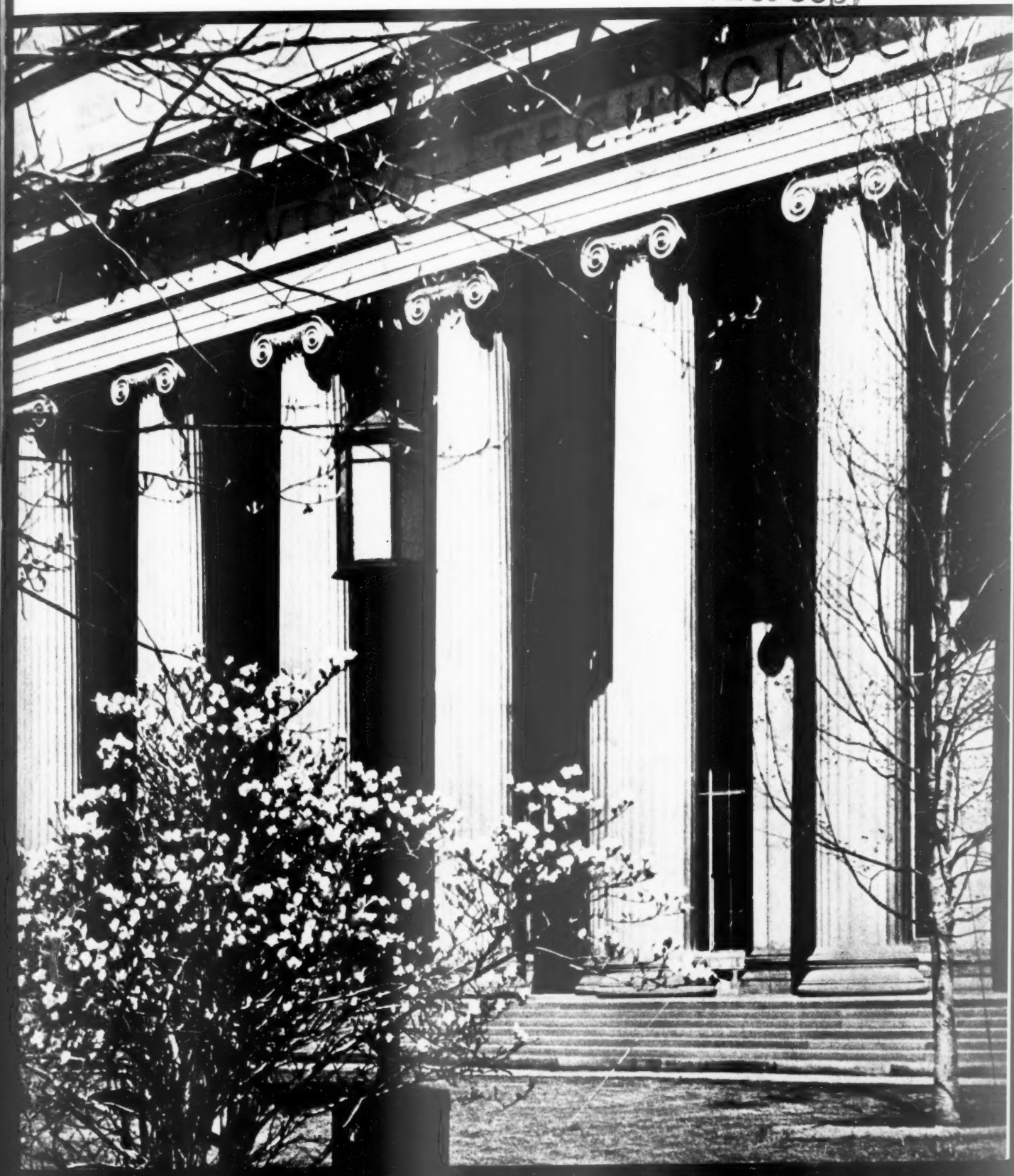

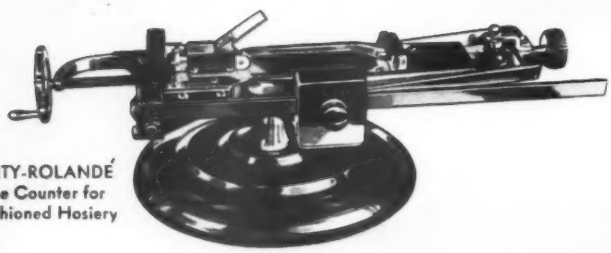

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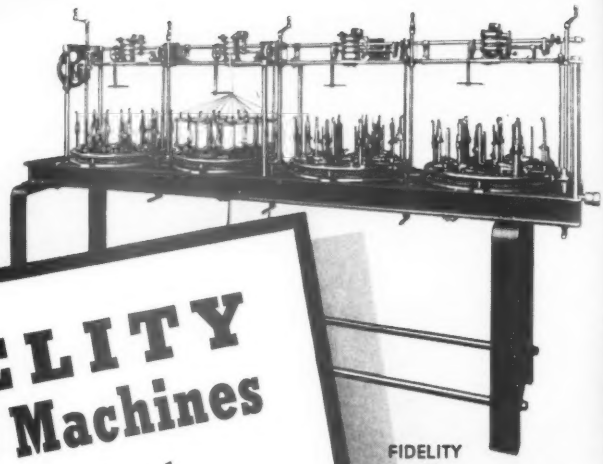

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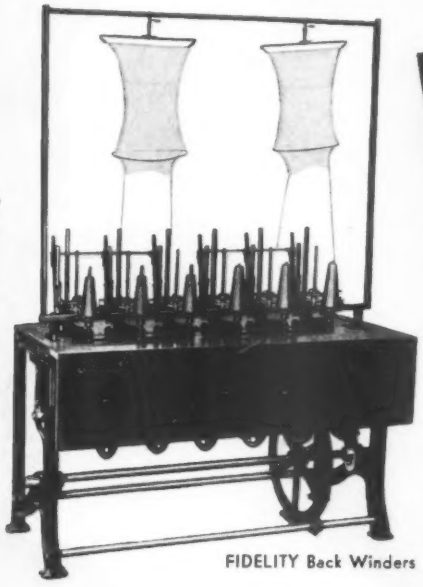

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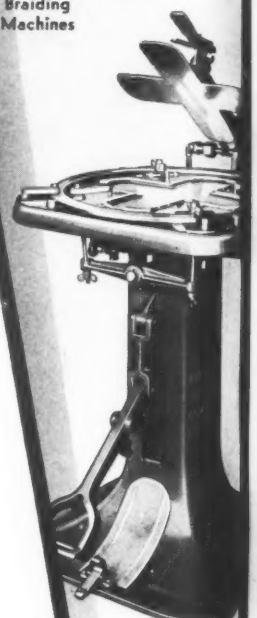

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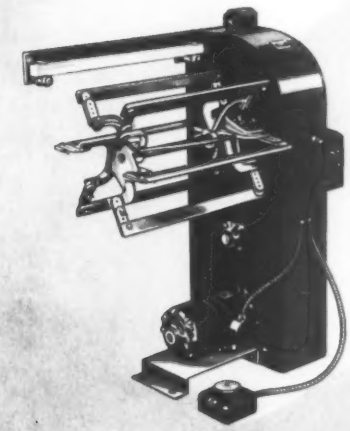

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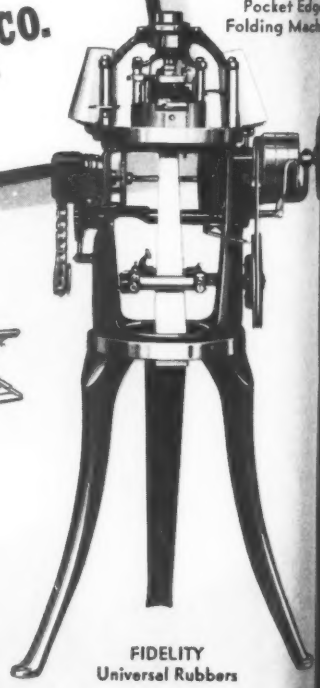

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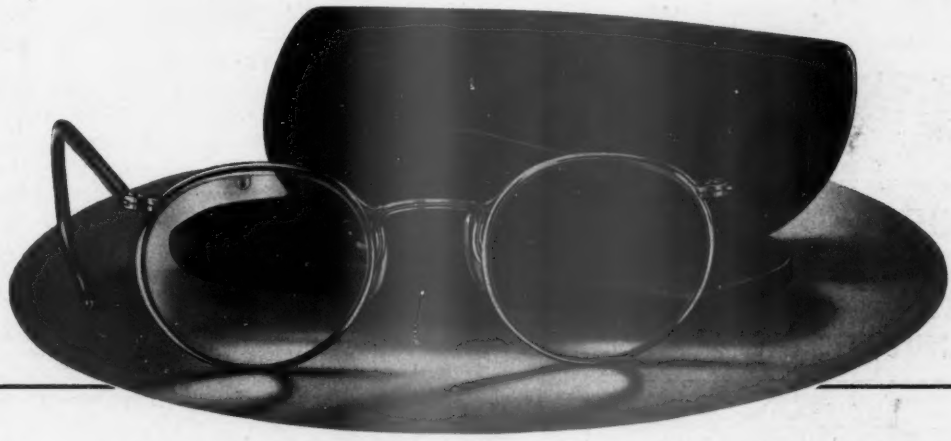
Look this Fact Straight in the Eyes:

You Can't Control Your Costs *Until Your Workers Wear* Goggles



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No. 34

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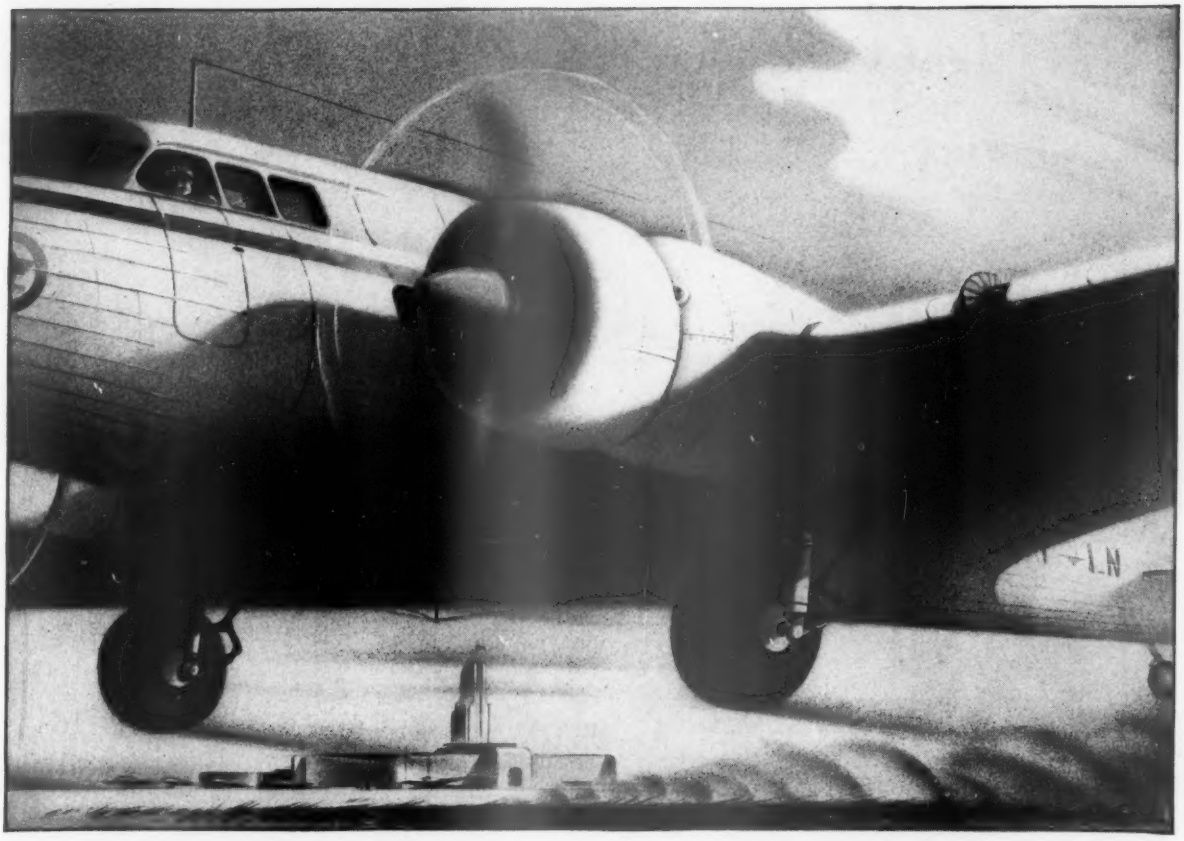
THE TABULAR VIEW

Curare Cure. — To bring the unruly into useful order is no small part of the function of science, expressed in hundreds of different fields, conspicuous among which is that of medicine. Here known techniques, predictable therapies, reliable drugs, and other agents have been provided by scientific research to sustain the skill of the practitioner in his efforts to insure mankind against disease. This constantly continuing endeavor of science has only in comparatively recent years come much before the general eye, and still the drama and the inspiration which such endeavor affords yield place too often to the more spectacular appropriating of science for less desirable ends. Much interest therefore attaches to RICHARD C. GILL'S account (page 297) of the taming of the jungle arrow poison, curare, which during the past few years has been converted from a mysterious and undependable witch doctor's brew to a predictable and highly useful physician's medicament. A graduate of Cornell, Mr. Gill was for a time a member of the faculty of Lafayette College. Thereafter he was in commercial foreign service in South America, where in 1929 he acquired a ranch in the eastern sub-Andes which he has since used as a permanent expeditionary base for his own work and that of others with bona fide interests in exploration and investigation. Starting with general ethnographic surveys of the region, Mr. Gill became specifically interested in primitive Amazonian *materia medica*, out of which grew his work on curare.

Mercury. — Stone breaker in Australia, timber cruiser in Canada, copper miner in Arizona, RICHARD HALLET has included also in a crowded life intervals at sea as seaman on a British bark, fireman on a British mail packet, and watch officer on a United States Army cargo transport carrying horses to France in the days of the first World War. Hence he writes of destroyers (page 299) with the comprehension of ships and men which is attainable only through varied experience, and with the reflectiveness about states and systems which is to be had only from retrospect on such experience.

Boost. — Speed and more speed and how to get it constitute a problem generally in the fore of aeronautical minds. The physical limits imposed on what can be attained by one means must be offset, if possible, by resort to some other means. On this front, then, the engineering experimenter is seeking ways to supplement by unusual techniques the standard approaches to his problem. This critical business is canvassed for The Review (page 302) by PAUL COHEN, '35, Editorial Associate, able editor of *The Tech* in years past, and frequent contributor of shrewd analyses to The Review in years current.

Antique Artisans. — From his explorations of technology's past, LEROY L. THWING, '03, has returned before to The Review with anecdote, legend, and history — most recently in Decem- (*Concluded on page 326*)



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MAIL RETURNS

Industrial Economics

FROM B. EDWIN HUTCHINSON, '09:

. . . I want to speak very highly of an article in the March Review by Henry M. Wriston on "The Worth of the Initiative." In a not too indirect way the thoughts in this article, in my opinion, bear on the subject of the Institute's prospective activity in the field of industrial economics. I have a feeling that our industrial techniques have far outstripped the development of our economic philosophy. I find myself groping to suggest some method which might bring the potential resources of the Institute to bear more directly on this larger problem. . . .

Detroit, Mich.

Teaching Fire Control

FROM FRANK L. AHERN, '14:

I have read with interest in the March issue of The Review the article, "Sir Thomas Gresham's Picture," by John E. Burchard, '23, discussing the effects of fires on cities. . . .

In my article, "Safety Is Good Management," in the March, 1940, issue of The Review, you will recall that I placed some emphasis on the suggestion that the fundamentals of fire protection and safety be included in engineering and architectural courses. It is a satisfaction to report that a course in fire protection engineering is now being given at George Washington University in connection with the Engineering Defense Training Program sponsored by the United States Office of Education.

Washington, D. C.

Small Arms for Industry

FROM ROBERT H. JOHNSON, '26:

The editorial, "Small Arms for Industry," on page 241 of your April issue is very interesting. May I inquire from what source you obtained the figure of $20,000,000 as the volume of portable-tool business for 1937? As far as I know, accurate figures are unavailable, since a large section of the portable-tool industry makes no reports on volume of sales. [The Review's figure was based on Bureau of the Census statistics for 1937. — Ed.]

You refer to the use of portable tools in the construction of battleships, locomotives, and airplanes, and go on to say: "A husky miner pounding at rock with a steel and a hand hammer can bore little more than five to ten feet of hole during an eight-hour day, whereas a modern pneumatic drill during the same time can penetrate 100 to 150 feet of rock." Yet you state later that the typical tool is driven by a high-speed universal motor through reduction gearing. In the applications to which you refer and in the various forms of hand tools which you list, a large percentage of the machines are hammers. In almost every instance they are operated by compressed air. In addition to these percussion-type machines, many of the rotating tools . . . are air operated. One can therefore hardly say that the typical tool is driven by a high-speed universal motor. The typical tool in the industries you mention is, I believe, air operated.

In the fifth paragraph you mention certain circumstances under which the power-driven tool is not only faster but better. You say: "When supplied with an adjustable clutch, a nut runner will set nuts to within 10 per cent of a predetermined tension, much closer than can be expected of handwork." A pneumatic tool without an adjustable clutch will accomplish this result when supplied with reasonably uniform air pressure, corresponding to reasonably uniform voltage for an electric tool. Moreover, the air tool does not require an engaging clutch when repetitive operations make necessary several engagements of a screw-driver bit or chuck in rapid succession. In this circumstance the electric machine would require not only an adjustable clutch but also an engaging clutch, because the inertia of the motor would cause the screw-driver bit or chuck to continue to spin for an appreciable time after disengagement, making it impossible to start another operation instantly. . . .

In general, not any known method of power transmission commercially available to an industrial plant will give, in proportion to power, the light weight and small size that compressed air gives. . . .

Pelham, N. Y.

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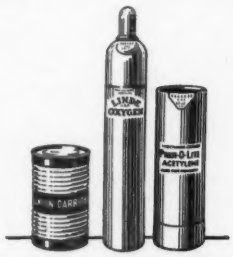

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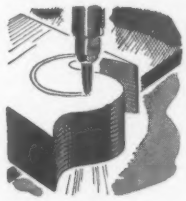

Flame-Cutting—Oxy-acetylene machine flame-cutting produces finished or semi-finished steel parts of almost any size, shape or thickness—rapidly and economically. Flame-cut parts, when joined by welding, make possible substantial savings in weight and bulk. In addition, flame-cutting simplifies design changes — enables manufacturers to hold down parts inventories—lessens dependence on outside sources of supply—minimizes machining time and expense—and makes one-of-a-kind production economically practical.

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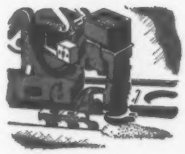
Gouging—This relatively new Linde process removes surface metal without harm to adjacent areas. It is used to gouge out faulty or temporary welds—to correct defects in forgings or castings—to provide clearance for moving parts—and to prepare plate-edges for welded fabrication.

Hard-Facing — To make wearing parts last longer, Haynes Stellite hard-facing materials can be most effectively applied by the oxy-acetylene welding flame.



Unionmelt Welding — This remarkable electric process—available only from Linde—automatically joins metal of practically any commercially used thickness, in one pass and at extremely high speeds. This process offers interesting possibilities in the fabrication of machine bases.

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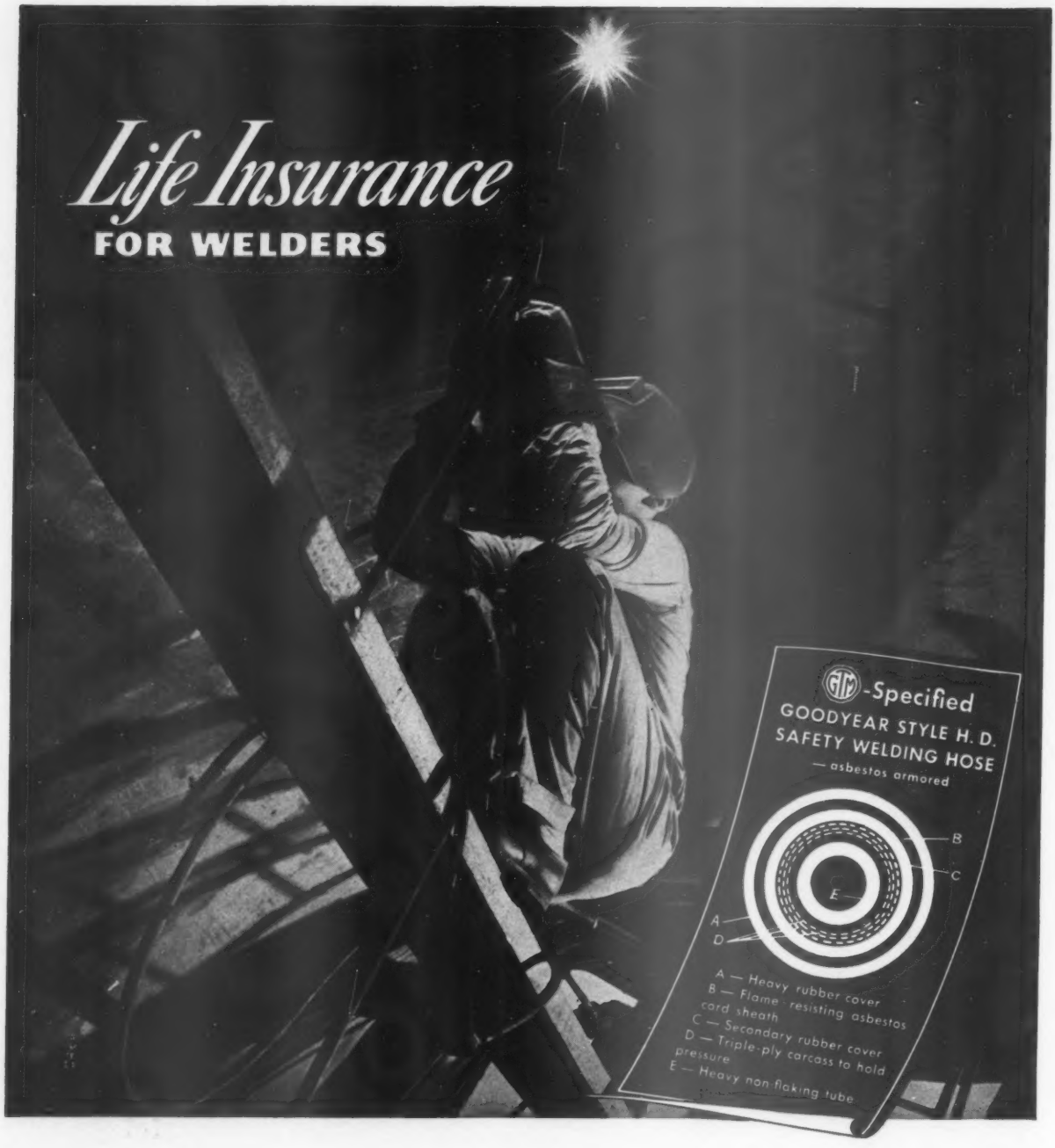

WELDING in close quarters has long been one of the more dangerous jobs in industry. Should the incandescent metal-fusing flame accidentally hit the gas-feeding rubber hose lines, they burn through instantly — *and wham!* Explosions have put many a welder on the casualty list. But fortunately, this peril has now been practically eliminated by the G.T.M. — *Goodyear Technical Man.* Seeking a way to protect welding hose against flame while keeping the flexibility required for work in narrow confines, Goodyear technicians hit upon asbestos. A special, heavy asbestos cord was developed that could be woven into hose plies like ordinary cotton cord, and Goodyear Style H.D. Safety Welding Hose was born. Its asbestos armor prevents burning through from accidental contact with the torch or gobs of molten metal. It saves welders' lives — *because it has a ten times higher safety factor than conventional hose!* Goodyear now builds many types of asbestos-bodied hose for operations where intense heat must be endured. To consult the G.T.M. about them, write Goodyear, Akron, Ohio or Los Angeles, California —or phone the nearest Goodyear Mechanical Rubber Goods Distributor.

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VOLUME 43 NUMBER 7

THE TECHNOLOGY REVIEW

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AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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From a photograph by Carl A. Segerstrom, Jr., '39

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THE
TECHNOLOGY REVIEW

Vol. 43, No. 7 May, 1941

The Trend of Affairs

Hot Stuff

EIGHTEEN months ago a group of 800 scientists met under the auspices of the American Institute of Physics to hear 125 assorted papers on heat. The men were generally learned, the papers usually abstruse. Now the papers appear in a volume of many pages and many pounds, called *Temperature.** For the Editors of The Review to attempt to understand all or even much of what is said on those pages is futile; to attempt an interpretation, foolhardy. The tome has an amazing amount of human interest, and to that aspect we may address ourselves.

Temperature has a long and honorable past in the history of science. Fire was one of the Aristotelian elements, but perhaps the scientific history of heat began when Count Rumford made quantitative measurements while boring the King of Bavaria's cannon. Since that day, names of those who have had to do with heat would include nearly every shining light in the galaxy of science. Helmholtz, Carnot, Kelvin, Joule, Regnault, Rankine, Gay-Lussac, Boyle, Berthelot, Kirchhoff, spring easily to mind.

But in spite of all the attention which has been paid to the subject, science apparently has not yet taken a really firm position with respect to temperature. It might encourage the belabored social scientist to hear the men of this symposium questioning the reliability of their physical constants. Certainly the student of language will be pleased to learn that the American Standards Association has under way a project for the standardization of letter symbols for heat and thermodynamics (its expositor remarked plaintively, ". . . Let us visualize the millennium when all technical authors are tame. . . ."). Finally, and most exhilarating, might be the statement by one of the attendants that the "mathematical physicist resents basing some of the fundamental laws of physics upon a sensation — warmth versus coldness in the skin of a man."

Measurements of the heat itself constitute a first base. There are so many methods and so many instruments for arriving at quantitative values that one hesitates to embark on an enumeration. Contact methods include those which rely on the expansion of test bodies (solid, liquid, or gas), on thermoelectric junctions, on electric resistance, on radiation from the test body in gas, on change of state of a test body, on calorimeter pyrometers, on suction pyrometers, and on methods for which additional heat is supplied. Among noncontact methods are blackbody-radiation measurements of various types, including optical and photo-electric pieces of apparatus.

That which is measured is, however, of considerably more interest than how it is measured. The present gamut of temperature measurements is very large, although in one of the places most important to practically all of us it is very small indeed. As Dr. Eugene F. du Bois has reminded us, man really lives not in the air but inside his own skin. Inside that skin the variation of temperature is not great. On a cold day the variation might be as much as 8 degrees Fahrenheit from the liver to the skin. Across a day the temperature at the same point might normally vary by less than 2 degrees Fahrenheit, but 2.7 degrees Fahrenheit can be gained in a hurry by playing squash. Emotion and age will affect the body temperature, too, but not to such a great

◀ *"Night Scene," by the late John Skara, examples of whose work The Review has presented in the past. Thanks to W. C. West, '11, and the Chicago Camera Club, others of Mr. Skara's prints are to be published in the future.*

* New York: Reinhold Publishing Corporation, 1941. xiii and 1,362 pages. $11.

extent; and it is apparently not true that women on the average have higher body temperatures than men have.

All these facts and many more which we shall also painstakingly lay before the reader are drawn from the symposium papers which deal with body temperature. Twenty-two out of the total of 125 consider this subject. The statements are based on large numbers of measurements of body temperatures made under closely controlled conditions which insisted on standardization of the time since the last meal, the posture, the environment, the length of time the thermometer had been inserted before the reading.

Although the body temperature ordinarily is quite steady, it is a matter of great concern to many people. Again quoting Dr. du Bois: "Many people do not merely own clinical thermometers, but worship them, and particularly do they worship the little arrow, guiding the activities of the family by this fetish." Yet people can attain temperatures which would break the family thermometer at either end. A man may have a bodily temperature about as low as 75 degrees Fahrenheit or about as high as 113 degrees, and yet live.

He can, of course, do much better than that as to the temperature of the environment in which he can live. He can live in Verkhoyansk in Siberia, which has the lowest recorded temperature, −90.4 degrees Fahrenheit (though there are some less sure claims for Mount McKinley at −100 degrees); and he can live in Tripoli when the day is 136 degrees Fahrenheit (only 2 degrees higher, incidentally, than the best record in the United States, made in Death Valley).

The evidence of the symposium on the subject of climate may re-assure more than one gaffer who, like your Editors, has gone around recalling the deep drifts formed by the swirling snows of yesteryear. The days are actually getting warmer. The long-time trend is definitely up, and the trend is world wide. Seventeen of the last twenty years in Portland, Ore., for example, have been warmer than the long-time average; nineteen of twenty in Cape Town, South Africa, have shown the same result. In New Haven, Conn., which is typical, the average fall build-up has been from 51½ degrees Fahrenheit in 1860 to 54 in 1936. But an individual does not really have to get off the familiar earth or even go to places where man could not go if he wanted to, before temperatures are likely to get too low or too high to be good for him. Fumaroles, for example, show heats of 230 degrees Fahrenheit to 1,500. It is hard to measure the temperature of lava surfaces, as optical methods are affected by dust, but one such report gives 1,904 degrees Fahrenheit for the temperature. On the other hand, radiosondes, parachuted from the upper air from balloons, may show the temperature aloft to be −76 degrees Fahrenheit at a pressure of 100 millibars, while directly below at a pressure of 950 millibars the temperature may be 64.

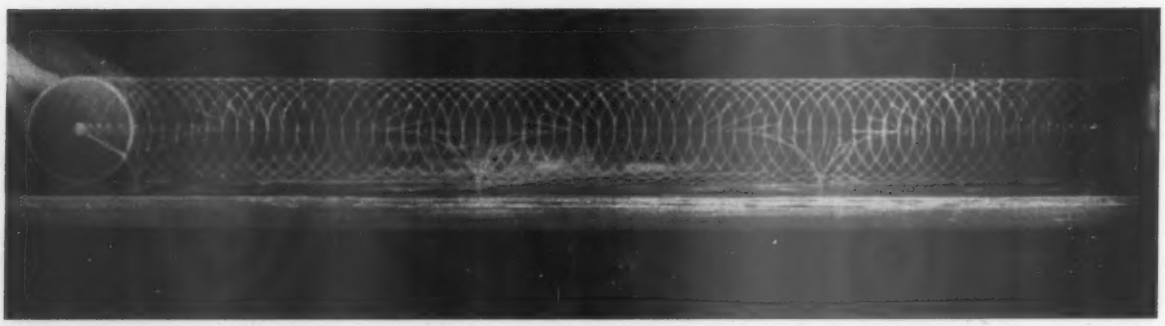
If you want things colder than that, it is best to go to the planets. The man who survived a winter at Verkhoyansk might do all right on Mars, which is about freezing at its equator, −94 degrees Fahrenheit at the polar caps by day, and averages −76 by night. But he would probably quail at Jupiter, Saturn, and Uranus, which measure −211 degrees Fahrenheit, −238, and −301 in that order. The moon is a testing place, for it boils by day and reaches −238 degrees Fahrenheit by night. Of course man improves on that lower temperature when he liquefies hydrogen or helium.

Man also does well with high temperatures, though he may not compete with the sun. Thus he has readily produced temperatures which melt gold (1,945 degrees Fahrenheit), beryllium (2,336), tungsten (6,170), or carbon (6,692). Neat devices for reaching high temperatures without alteration of pressure are afforded by such gadgets as Straubel's solar furnace at the Zeiss Works in Jena. A heliostat with a 100-inch searchlight mirror focused on a 5/16-inch spot yields a temperature of 5,400 degrees Fahrenheit. Other ways of producing great heat are electron bombardment or the explosion of wires by the process of discharging condensers through very thin filaments.

The effects of temperatures on life are among the most interesting matters reported in the symposium papers. Differences in temperature can have substantial influence on such disparate things as the respiration of seedlings, the heartbeat frequency of a cat, the motions of a paramecium, the death rate of *Bacterium typhosus* in mercury chloride, or the pupal development of the meal worm.

A good deal of debate has centered about reproduction rhythm, which appears sometimes to be affected by temperature rhythm but more often by sun rhythm or

Recalling the penmanship exercises of years past, this end view of a cylinder rolling along a plane is another of the teaching pictures developed at Technology by Harold E. Edgerton, '27, Associate Professor of Electrical Measurements, and Francis W. Sears, '20, Associate Professor of Physics, for use in the teaching of physics. In the successive-flash photographs, the radius painted on the end of the cylinder is seen to describe a cycloid.



diet. Fish undoubtedly migrate because of changes in temperature, but birds, which need a long feeding day, are perhaps more influenced by the course of the sun. Finally, though cold weather — at least down to zero — will not affect the milk yield from cattle, high temperatures will reduce the milk a great deal and the casein content appreciably. This fact poses a neat problem because it is very hard to cool a cow, which happens to be a nonsweating animal. Did you know that?

Of course, all the papers did not deal with such things. A substantial amount of the symposium was devoted to the discussion of control of temperature. Controls are the tools of production, as measuring devices are the instruments of research. The book contains interesting discussions of high-speed measurements of temperature in oil refining, of the control and measurement of temperature under a microscope. The uses of control are countless: in refrigerator cars, the food industry, stokers, steam turbines, plastic molding, massive concrete structures, aircraft, liquid metals, incandescent lamps, petroleum production including thermal prospecting. In medicine are the fever cures of gonococcus and spirochete infections and the experiments in the cold treatment of cancer. The book as a whole is a convincing demonstration that Prometheus has been bound.

A CONTEMPORARY book of almost as much volume and weight may serve as antithesis, for in it one finds the furies of Prometheus out of control. The Crosby-Fiske-Forster *Handbook of Fire Protection* * also has its human interest in addition to its many useful tables. Here one can find that the annual fire loss in the United States averages $300,000,000; that dwellings account for 390,000 out of 660,000 fires; that practically half of all deaths by fire occur to children and old people. Of those who burn to death, about 25 per cent are trapped in burning buildings; no other cause is very important, but hanging around aircraft or fixing the furnace in loose clothes may result in disaster. Though "smoking and matches" are the largest single fire cause, they do not result in many fatalities, and a large number of people will be relieved that smoking in bed is not a very important source of trouble. Similarly, the old theory of "rats and matches" is apparently debunked, for rats will starve before they will chew a match head.

In addition to the expected sources of fire, such as cigarettes, oil storage, chimney sparks, and lightning, the sun often plays tricks. It focuses through glass paperweights, fish bowls, or even lenses formed by bubbles in window glasses, and presto! the blaze is on. Incidentally, the lightning hazard need not scare you much if you live in New England or New York, which have averaged twenty to thirty days of thunderstorms a year for the last thirty years. But look out in New Mexico, which runs to sixty-seven such days, and especially in part of Florida, where ninety-three days are the rule.

The book, too, recalls the nostalgic past. The biggest fire disasters since 1900 remain the *General Slocum* and the Iroquois Theatre fires; while in more recent days — those of the last decade — there were about forty $1,000,000 fires, which include those of the Chicago stockyards, Coney Island, the *Morro Castle*, and the *Hindenburg*.

Serious "sparks" can find much information on apparatus, hose and couplings, and all mechanical contrivances, including foam systems, sprinklers, carbon dioxide systems, steam-smothering systems, signaling systems — in short, in 1,308 pages everything about fires except the checker rules which prevail in the firehouses.

IF, however, a layman wishes to do serious reading which he can understand and perhaps use in the field of fire, he may best turn to a third volume. *Fire Defense*,† just published, is a clearly written and profusely illustrated book reporting what has happened to Europe under the rain of incendiary bombs and giving instructions on what can be done to minimize difficulties which might arise here, including those of arson by the saboteur. This is a book to be taken seriously, for, as we have been reminded by Attorney General G. D. Conant, chairman of the Ontario Civilian Defense Committee, "Attack, either from within or without, is a risk which cannot be ignored in view of events in other countries."

So, with obeisance to science and compliments to fire-protection engineering, The Review ventures for the moment to lay the wreath on the book devoted to defeating the satanic aspirations of man.

* Boston: National Fire Protection Association, ninth edition, 1941. xxiv and 1,308 pages. $4.50.

† Boston: National Fire Protection Association, 1941. x and 221 pages. $1.50.

Rolling down an inclined plane, this cylinder photographed end-on by Edgerton and Sears provides visual answer to the question of whether the rim of the locomotive wheel travels faster than the locomotive. It does, in the ratio of two to one, at the top of its revolution, and slower in the same ratio at the bottom, as inspection of the relative positions of the painted radius, rim spot, and center in successive pictures will show.

Wrap It Up

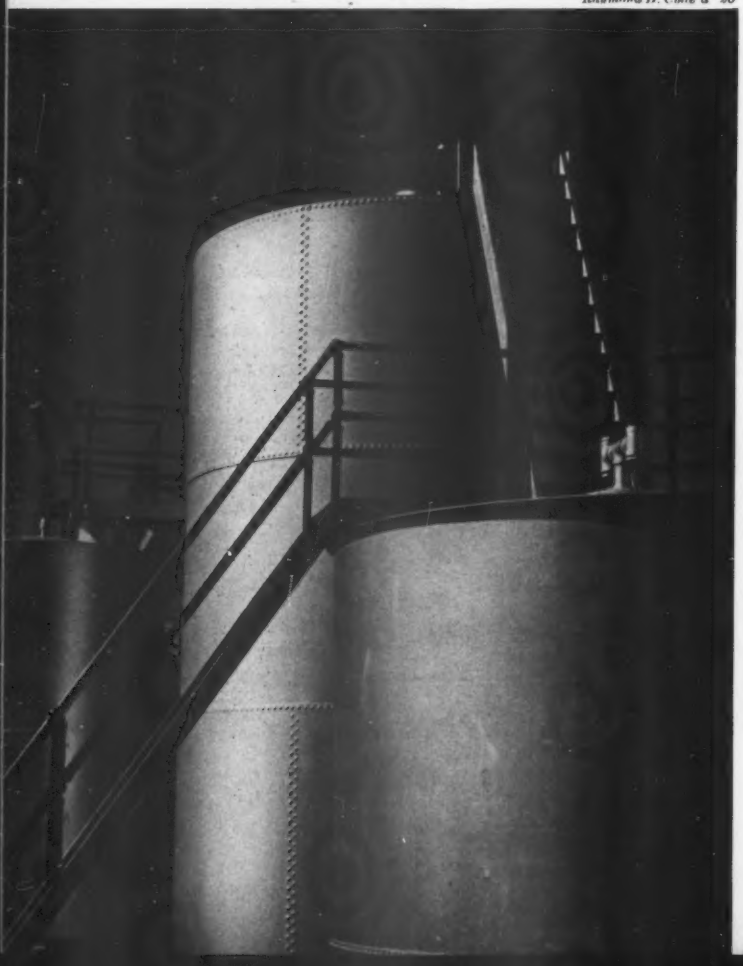
FEW chestnuts are more hollow chested with age than the one about the shopper who agreed to buy the yard of milk provided it was wrapped up. Packaging of milk has been in recent years a focus of attention more prolific in argument and counterclaims than in anecdotes of even this quality. Milk in waxed paperboard, milk in molded wood pulp, milk possibly in tin — these have been among the projects to replace the glass bottle. The versatile plastics, in the judgment of some designers, may provide the next addition to the debate. Milk bottles modeled out of plastic material have already been shown by industrial designer Clarence P. Hornung. Constructed so as to be closed by means of metal caps put in place by existing capping machinery, the Hornung bottles are designed with pouring spouts. Pleating of the sides and polygonal treatment of surfaces are more practicable with plastics than with glass.

Another Hornung project recently in the news is a "quadri-can" — a tin can divided by diametrical partitions into four inner compartments, each of which may be opened by a key device. Heating the whole can in a single pan of water, the housewife then would open it and serve the four different foods occupying the compartments. Simplification of housekeeping and stimulation of sales of related products in a manufacturer's list are cited as advantages of the scheme.

The synthetic sheeting materials which have already become familiar in their work as raincoats, shower curtains, and so on, are looking to the packaging field as not a future possibility but an immediate venture. Resistance to outside exposure, such as sunlight, oxygen, and temperature changes, is stressed by one manufacturer as a virtue of his product. Re-usability of the packages is emphasized by another. Waterproof qualities and the advantage of visibility of contents are likewise cited. Wrapping of citrus fruit in a skin of transparent synthetic is advocated as a means of preventing spoilage and of preserving appearance and flavor.

Packagers have, more than most people, to reckon with the average consumer's whims and prejudices, such as, for instance, a belief recently uncovered in surveys preliminary to the acceptance of designs of a new line of bottles for pharmacists to use when filling prescriptions for doctors. This idea, which came as a surprise to the bottle manufacturer, is that a short, squat bottle holds more than a tall, slim one. Prescription bottles of amber glass were accordingly designed with this belief in mind and, as a consequence, will fit more readily on shelves of the family medicine cabinet or in pocket or purse. Use of amber glass in prescription bottles is held desirable as insurance against depreciation of contents by radiation admissible through ordinary flint glass.

Gasoline tanks at Fisherman's Wharf in San Francisco set the mood for this display of cylindrical forms in varied industries.
Raymond B. Colle'd '40



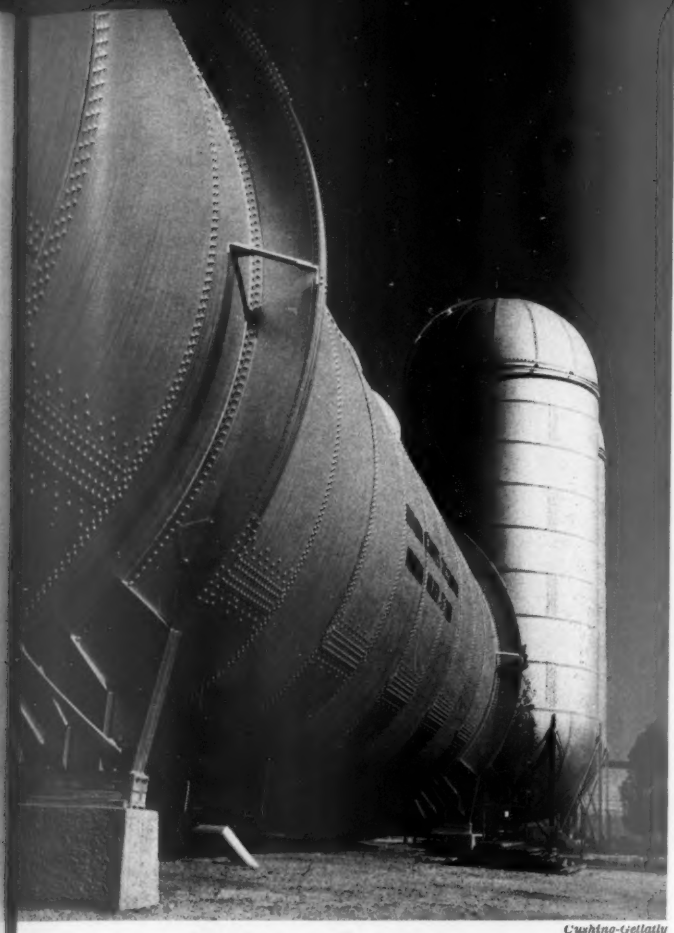
Mine and Countermine

WITHIN its limitations the mine affords an absorbing study, undoubtedly one of the most thrilling games the amateur tactician can play and a fascinating field for the professional soldier looking for honors or his fate. In what is perhaps the first book to be devoted to mine warfare,* Archibald M. Low, a British writer, not only traces the history of mines from the fire ships Appian described but also, as far as censorship restrictions permit, brings us up to date on this form of the military art.

Real knowledge of mines dates only from the 1860's and that great proving ground, the Civil War. Early efforts were concentrated on the idea of moving a load of explosives into contact with the underwater portion of a naval hull. Not until Whitehead's automobile torpedo had solved that problem was the mine developed primarily as a stationary defense mechanism.

When the confusion of its purpose was cleared away, the mine rapidly built up a record of destruction which far surpassed that of the torpedo. During the Russo-Japanese War many ships were sunk by mines, but not one fell victim to a torpedo. At Jutland 926 torpedo tubes were ready for business, yet of a hundred large ships exposed to their menace only three were seriously damaged, while at Gallipoli alone several Allied ships were mined. It remained for German ideas of war making, through attacks on merchant shipping, to achieve the destruction expected by advocates of the torpedo. Since that policy was instrumental in securing the armed intervention of the United States, however, it worked heavily against its originators. Now, once more, the torpedo leads in hits in the box score of war and again operates to draw powerful allies to the enemy's side. Meanwhile, the evolution of mine warfare has been

* *Mine and Countermine* (New York: Sheridan House, 1940). xi and 224 pages. $2.75.



Cushing-Gellatly

A gas company's holder station at Monrovia, Calif.

exceedingly rapid, especially from the time when an adequate supply of modern mines became available to the British in 1917. Whereas the defense of Mobile Bay in 1864, one of the most ambitious undertakings of the Civil War, was done with eighty mines, the North Sea barrage, laid in 1918 with Britons and Americans co-operating in the work, comprised 172,000 mines.

Although many special types of mines have been developed, the moored contact mine is standard today. Enlarged in size and improved in reliability since World War days, it is an efficient piece of machinery. But its role is passive; it will hardly win a war. Its strategic function is to restrict the mobility of enemy vessels; it cannot destroy them if they do not move into the wrong places, and even if they do, the use of paravanes greatly reduces the risk. Some authorities speak of "offensive" mining, but it is almost self-evident that an unprotected mine field is a waste of time and money, for a mine field can be swept more cheaply than it can be laid. Thus, in the end, the success of mine warfare depends on the naval and air strength that supports it.

The early discovery of the magnetic mine, the dissection of that first awful specimen, and the prompt development of a cheap and adequate retort, the degaussing girdle, seem to Professor Low to be partly fortunate, partly routine incidents of the present war. From this and many other stirring accounts he goes on to explore the possibilities of land and aerial mines.

Although the land mine is more ancient than gunpowder, it has found a new vogue in the need for a defense against the tank. As is true of mines in naval warfare, the land mine has, in the barbarous fashion of ruthlessness, often been perverted into use as a mantrap equally dangerous to friend or foe, military or civil, thus verging on the infernal machine of the assassin. But if a land-mine sweeper has not yet appeared, neither has the land mine itself succeeded in halting for long a resolute advancing force. With any such device, the psychology of novelty and surprise may yield valuable temporary results; thus, in the battle of Jutland, the fear of underwater attack weighed on the British, affected the day, and may have served to prolong the war, but it did not reverse the balance of power at sea.

The barrage balloon and its mooring cable form a kind of aerial mine. Explosives are unnecessary because of the relatively delicate construction of aircraft. A space, rather than an area, must be mined, but the dimensional effect of the cable is in a line rather than a point, so that the geometry is somewhat similar to marine mining. Notwithstanding its homely appearance, the barrage balloon has been effective in forcing the attack to a higher altitude and preventing a straight run over a target area, especially at night.

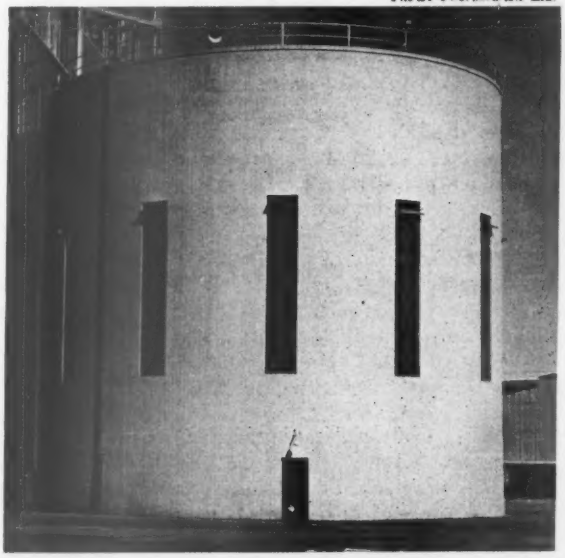
A long cable is difficult to support, for mild steel wires in still air are stressed to the working limit by their own weight at a height of about 25,000 feet. The suggestion of parachute-supported wires or cords shot up to high altitudes has already been advanced. An adequate defense against indiscriminate night bombing remains to be found, and the logical reply of destroying the enemy air bases seems to be the most promising line of endeavor, with the issue hanging on air power.

Argosies Tabulated

AS an element in the export trade of the United States, books do not bulk very large in terms of dollars (total exports of bound educational books, other bound books, and unbound books in sheets were valued at

Circular breaker station at Broken Hill, New South Wales, Australia. The Broken Hill ore body is, for its size, the richest individual producer of silver, lead, and zinc yet discovered.

The Zinc Corporation Ltd.



SHRIMP are the reason for the industry pictured here by C. E. Patch, '02, in photographs showing, in the usual order, two shrimp boats hauled out in the repair yard at Cut Off, La.; a shrimp boat at Biloxi, Miss., rigged for oystering, when she will carry a deck load inside the bulkhead aft; and the Colter Lagoon at Palacios, Texas, with craft readying for work. In the bays along the Gulf Coast, two men to a boat shrimp for three months, using an otter trawl, then dredge for oysters for an equal time. Deep-sea workers, like those who operate out of such ports as Morgan City, La., and Galveston, Texas, work practically the year round, three to a boat. Of the $10,000,000 product, about half is canned, the rest being sold fresh or frozen. Half the take from a trip goes to the crew, who find themselves and buy their own ice for keeping the catch, and half goes to the owner, who keeps up the boat and buys gasoline.

$4,505,950 in 1940), yet statistics concerning them are important. Books going to foreign lands may well be regarded as argosies outward bound with cargoes of characteristic ideas; the consignees who authorize such lading are seeking more than paper, ink, glue, thread, cloth, and binder's board. Hence there is special interest in the fact that Argentina stepped into fourth place among importers of books from the United States in 1940, spending $295,142 for textbooks alone. Brazil, Colombia, Venezuela, and Mexico also bought many books from the United States in that year. Almost one-half of the entire export book trade of the United States went to Canada, with a total valuation of $2,242,116, of which $1,564,320 went for other than educational books. Book exports from this country have declined steadily during the past three years, the drop from 1938 to 1940 being over a million dollars.

Preliminary figures released by the Bureau of the Census for United States production of books in 1939 show a decline of 9 per cent from 1937, the figures being 180,142,492 volumes for 1939 as opposed to 197,359,076 for 1937. Bibles and Testaments still head the lists of volumes published on a single subject in this country, the total for 1939 being 7,947,848 as compared with 5,579,317 for 1937. Titles in science and technology continued the climb which they began in 1935 after a depression slump in 1933. In 1939, the total in this category was 3,432,642, an increase of well over a million copies above the figure for 1937. The Review noted in December, 1939, that versification had not yet struck bottom in the decline in number of volumes of poetry and drama published. Seemingly, the end is not yet, for titles in this field in 1939 amounted to 1,499,477, a loss of almost 300,000 from the total for 1937. The 1939 total for fiction, 13,511,181, shows a remarkable drop from the 25,454,135 volumes in this class published in 1937, and titles in medicine dropped more than a million from the 1937 figure of 3,923,532.

Defeated

REPULSE of a sinister invader in South America is reported from the New York headquarters of an army of science, over two thousand strong, which in the past three years has been waging unsung war on insects. The invader in question was the dreaded malaria-carrying mosquito, *Anopheles gambiae*, native of Africa. Apparently taking advantage of man's means of transportation, it had sneaked a ride across the Atlantic in an airplane or on one of the fast French destroyers which, about eleven years ago, were serving the French air line between Dakar in West Africa and Natal in Brazil. The mosquito was discovered in Natal in 1930 by a member of the staff of the Rockefeller Foundation.

In collaboration with the Brazilian Government, the foundation in 1938 began organization of a systematic campaign to halt the alarming spread of the insect, which produced an especially virulent form of malaria. How necessary the campaign was, is indicated by the sweep of the disease as the mosquito worked up the coast, following the prevailing winds. More than ninety out of every one hundred persons in the Jaguaribe Valley in the state of Ceará were affected by the disease during 1938. In some regions mortality was as high as 10 per cent, and the epidemic so disabled the population that no crops were planted.

Studying the mosquito and its habits, taking advantage of climatic changes, establishing fumigation and quarantine stations, and marshaling a trained field army of doctors, technicians, scouts, inspectors, guards, and laborers, the Rockefeller Foundation and the Brazilian Government by 1939 had pushed the gambiae back to its central strongholds in the main river valleys and on the narrow coastal shelf of northeastern Brazil. The great threat of the mosquito's breaking through to the well-watered Parnahiba and São Francisco valleys, whence it might have spread to a large part of South, Central, and even North America, appeared to have been stopped. The gambiae had covered half the 500 miles separating the Parnahiba Valley from Natal when its course was checked.

The frontiers of the infested region were marked by fumigation posts on every outgoing road, at which all departing vehicles were stopped, inspected, and fumigated. Beyond the farthest limit of the gambiae's advance, a ten-mile zone was kept noninfectible. All breeding places within this area were eliminated or were treated with Paris green or other larvicide. Since the gambiae breeds mainly in shallow pools open to the sun and without vegetation, every little depression in the ground, such as a hoofprint or a wheel track, which could afford a water surface for eight or nine days had

to be reckoned with. The carelessness or the unwillingness of mankind likewise was a source of possible trouble; once, an old automobile, using a jungle cart track and avoiding the fumigation post on the main road, carried the mosquito many miles into previously uninfested territory.

Intensive campaigning during 1940 resulted dramatically. By the start of the dry season the mosquito had been virtually confined to the lower Jaguaribe Valley, where a large number of workers were brought together for a final attack beginning in July. Dur.ng the last forty-seven days of 1940, no evidence of gambiae was found in Brazil. Summing up in his review of the foundation's activities for 1940, Raymond B. Fosdick, President, thus concludes the section dealing with this work, which has been headed by Dr. Fred L. Soper: "Those directing the campaign no longer consider it rash to speak of the eradication of the gambiae from Brazil, although it must be remembered that the struggle will not be won until the last fertilized female gambiae on this side of the Atlantic is destroyed. In any case, no matter how many isolated foci may yet be uncovered, the critical phase of this immediate campaign seems to be over. . . ."

The second great scourge of mankind which mosquitoes transmit — yellow fever — has likewise received a setback at the hands of Rockefeller Foundation investigators during the year past. The virus of this disease, it had been thought, was carried by the *Aëdes aegypti* mosquito and kept in circulation by a mosquito-man-mosquito cycle. Discovery, a few years ago, of the existence of the disease in parts of the South American jungle where were located no *Aëdes aegypti*, presented a mystery which foundation workers undertook to unravel. Two other species of mosquitoes were found to carry the virus, but no virus could be demonstrated in any form of insect life other than mosquitoes. Several broad groups of animals, ranging from men and monkeys to opossums, to anteaters, sloths, armadillos, and to various rodents were shown by tests to be susceptible to the disease.

From these and other lines of investigation, tentative generalizations have been drawn by the Rockefeller scientists. Yellow fever they deem to be primarily a disease of jungle animals; so the mosquito-man-mosquito cycle formerly regarded as of primary importance is looked upon as more of a secondary cycle depending in large measure on concentration of population and on conditions of mosquito breeding created by man himself. Jungle yellow fever, they find, appears to be transmitted from animal to animal by jungle mosquitoes, but there is no animal reservoir of virus in the usual sense. In the blood of an infected animal, virus circulates for three or four days but does not re-appear. After infection, however, mosquitoes harbor the virus for the rest of their lives, a period which may be for several months. Vaccination of people near infected forest areas appears to be the most important procedure for control of the disease. Studies among wild animals in a region may be used to determine risk to humans in entering the region.

Gallimaufry

WEEKLY laundry requirements of about 1,500 soldiers will be taken care of by a portable laundry unit which the Quartermaster Corps of the Army is at present developing. Mounted on a four-wheel semi-trailer, the unit will contain machinery and equipment necessary to do field laundering, including a washing machine, an extractor to remove surplus water from the materials laundered, and two steam-heated tumblers for drying. Thus are the appearance and well-being of the military man being provided for. Another machine-design project now engaging army officials is the development of a new sewing machine for use on celluloid, imitation leather, and canvas. The sewing-machine industry has co-operated in the devising of the new stitcher, to be employed on tarpaulins and curtains for motor vehicles. ¶ About a quarter century is the present life expectancy of the industry of dredging coal from the Susquehanna River in Pennsylvania, according to a writer in *Compressed Air Magazine*. In 1889, dredging operations began to recover coal swept into the river from mine breakers and culm or silt banks, and from waste piled up at collieries. Some 13,000,000 tons of "river coal" have been dredged up since that time, most of it being used for raising steam. About 20,000 tons a year, however, are utilized for recarburizing steel in the open-hearth process. (River coal, for some undetermined reason, is found to give better results than does ordinary anthracite.) In 1937, thirty-three dredges were in

operation on the Susquehanna and other eastern Pennsylvanian rivers, recovering 760,474 tons of coal valued at $842,052, average price received for a ton being $1.11. Sources that feed the streams are gradually diminishing as large breakers of new types are erected, as fine sizes are more generally utilized, and as silt is more securely stored. Something more than 500,000 tons of coal is estimated to be on the bottom of the Susquehanna at a time. ¶ A new opportunity for devotees of the bow and arrow is in use of the archer's equipment for paint-branding of deer in national forests. Paint brands are used to mark the animals in order to facilitate study of the extent of their traveling from one feeding area to another. Arrows tipped with sponge rubber dipped in varicolored paints are employed and do not injure the deer. The herds are so tame that a marksman can brand several animals from one shooting stance before the herd scatters. ¶ For one of the 2.5-ton trucks being built for the Army, more than 11,000 pounds of carbon steel, alloy steel, gray iron, and malleable iron are required. Shipping weight of the vehicle, however, is but 9,500 pounds, a fact indicating the large allowance for scrap that must be made in the manufacture of such a unit. More than thirty pounds of zinc, seventy of copper, twenty of aluminum, fifty-five of manganese, and eight of nickel are also used, plus 450 pounds of natural rubber, half a pound of synthetic rubber, and thirty-two pounds of lead. Eighty-six pounds of paints provide weather protection and reduce conspicuousness. ¶ Fly screens of vinylidene chloride, now under test in various parts of the country, are recommended as much less conspicuous than the standard black wire screen. The plastic screens are durable and resistant to corrosion. Strong, flexible strands which may be woven into attractive and long-wearing covering material are secured by the stretching of extruded vinylidene chloride. In some new air liners, bulkhead panels of this material are employed. The woven sheet has also been used as a seat covering in New York subway cars. ¶ Sixty-seven and four-tenths cents of the amusement dollar in 1939 were spent in motion-picture theaters, according to the Bureau of the Census. Billiards, pool, and bowling constituted the next largest group of amusements in terms of receipts; they collected 8.8 per cent of the total amusement expenditure of $1,850,355,000 in 1939. Horse and dog tracks took in 4.4 per cent, and the legitimate theater trailed individual categories with but 3.3 per cent. The remaining 16.1 per cent went to other amusement industries, including riding academies, amusement parks, and private swimming pools. ¶ Photography with soft x-rays, first used industrially in the textile trades some seven years ago, is at present being recommended as of possible value to advertising. Using rays of wavelengths longer than those of standard x-rays, such photography reveals details of texture and structure even to depths of half an inch within some materials, yet retains other details. Useful in testing textiles and chemicals for defects in workmanship, soft x-ray photographs may be employed to show the buyer what are the interior conditions of the goods which he considers purchasing. ¶ Followers of quiz programs, in an effort to stump the experts, have not yet made use of the beedie, despite the oddity of the name. Beedies are handmade cigarettes produced mainly by small establishments throughout India. Smaller and thinner than the standard cigarettes, beedies taper at one end, contain less than half the amount of tobacco used in a standard fag. A thousand can be rolled from about a pound of tobacco and will sell in Calcutta for about seventy cents for the best grade. Filler treated with various kinds of perfume is employed in some kinds. Low-grade domestic granulated tobacco is used in beedies, being rolled in a section of the leaf of a species of Indian ebony. ¶ The processing of cottonseed to obtain oil and protein feedstuff has as a by-product the hulls of the seeds themselves; a method for the utilization of these hulls may lead to increase in the cash va'ue of the cotton crop. University of Tennessee researchers have been studying means of using the cottonseed hulls as a filler for phenolic molding compounds — an idea suggested before but not adopted on a commercial scale. Strength characteristics of phenolic cottonseed-hull molding compounds, it has been found, can compare favorably with those of commercial phenolic compounds if size of particles and content of fiber are properly controlled. Specific particle sizes and fiber contents provide maximum strength. Pilot-plant production of small batches of the compound has been carried on with the co-operation of custom molders, one of whom has submitted bids on national defense orders based on a use of the new material. The compound is also being used in molded sheaves for looms, which have in the past been made from wood and have had to be replaced frequently because of mechanical wear.

"No Such Number"

SPINNING the dial of his telephone with haste or inattention, the subscriber may rather often set up a combination of numbers not yet assigned for service and thus may occasion delay to himself, delay to other telephone users, and expense to the telephone company. He may in addition, of course, make it easier for himself to commit the same mistake again, simply by the fact that he has set up an erroneous pattern of numbers in his own mind.

Development of a "no-such-number" tone which will sound through his receiver and inform him of his error, as the "busy" signal already operates, is hence of interest. For such work, the tone should be distinctive, and easily remembered and associated with the idea of disconnecting and dialing the number again. Bell System engineers have been working on the development of a circuit to supply a tone meeting these requirements and have devised one which supplies a note varying continuously in frequency, much as the note of a siren varies, alternately rising and falling at intervals of a half second. It is a train of oscillations whose fundamental frequency varies between 200 and 400 vibrations a second, each oscillation consisting of a fundamental and many harmonics. In field trials, the new system is reported to have proved distinctive and arresting enough to get immediate attention from the subscriber, and to have resulted in a higher percentage of correct numbers at the second dialing.

The Genie in the Ampoule

How the Discipline of Science Has Translated a Jungle Poison into a Useful Drug; Curare, Now Made Predictable, Becomes Another Servant of Medicine

By Richard C. Gill

THE genii of Arabian legend, no matter in what kind of bottle they were imprisoned, were rarely predictable when they were released. And certainly the genii in the foul-vapored, seething caldron of an upper Amazon witch doctor could hardly be termed predictable, especially (from the point of view of medical science) when the caldron contained curare, the erstwhile mysterious arrow poison of the South American jungles.

Through the discipline of modern science, however, the genie in a sterile ampoule of biologically assayed and standardized curare *is* predictable and *does* function to perform miracles. Administration of the drug results in relaxation of the striated, or voluntary, muscles, as, for example, in various states of so-called spastic paralysis. The achievement of a state of predictability is the essence of functional research, for predictability is the greatest and most important single characteristic of any medically usable substance, at least as regards the clinician, whose administration of a drug is that drug's ultimate destiny. Even the terminal result of the administration of any drug, no matter how valuable in an individual case, is quite worthless unless the result also can be predicted for general use.

Predictability is essential in the whole cycle of any drug: in reliable sources, in reliable materials at those sources, in reliable production of a substance which must be unvarying in its physiological reactions, in the technique of assaying and standardizing the product and of preparing it for its final human or even animal administration. The discovering botanist, who is frequently an ethnobotanist; the pharmacognocist, who might be called the liaison officer in the world of drugs; the pharmacologist and the pharmaceutical manufacturer; and, finally, the administering physician — each one bases his work on predictability.

Thus to make a drug predictable is, axiomatically, to make it functional. If curare could be made predictable in the field of medicine, a group of investigators decided some years ago, it would offer human values more than offsetting the labor involved in bridging the long and cloudy gap from the primitive jungle to the predictable ampoule. That gap, as those of us participating in the investigation now realize, was almost inconceivably long, and involved one of the most intricate pieces of expeditionary strategy which had ever come to our attention. The research was complicated not only by all the problems that one might expect to encounter in translating a lethal jungle poison into a functional hospital drug but also by the curious and constantly baffling fact that most of the earlier knowledge of curare was quite erroneous. This aspect of our problem — the most onerous aspect — was caused not so much by prevailing errors regarding the clinical usage of the drug, whose physiological actions have long been known, but by numerous misconceptions and *idées fixes* regarding both the origin and the intrinsic nature of the substance. Apart from published clinical observations, there was extant hardly one single item of information which was trustworthy in its *entirety* as a basis for tactical procedure either in the field or in the laboratory. A brief résumé of the situation regarding curare will best explain why we were forced to undertake this particular research on what was really a purely empirical basis.

From time immemorial, curare has been made chiefly by witch doctors, or medicine men, of certain tribal groups living mainly in the northern and northwestern sections of the Amazon basin and in the upper Orinoco. Crude curare is a dark brown to black gummy substance. In those regions in which we are interested, it is made by brewing, in water, combinations of the stems, bark, roots, and leaves of certain plants of the Menispermaceae, Loganiaceae, and other families. The resulting infusion is strained and then by being boiled is concentrated to a partially desiccated state for storage until it is used for poisoning the tips of blowgun arrows. In the Amazon, the primitive function of curare is confined almost entirely to the killing of game in hunting; the meat thus killed is quite edible. Use of curare in warfare is, contrary to some reports, almost unknown.

Used almost exclusively for hunting, the jungle poison, curare, is applied to the tips of blowgun darts.

Courtesy E. R. Squibb and Sons

The early Spaniards had long endeavored to ferret out the jungle mysteries surrounding the

making of this deadly primitive poison, but the first such records in English literature are not found until Hakluyt's description of Sir Walter Raleigh's voyage to the Orinoco Valley in 1595, where he says:

". . . [the Indians] have the most strong poyson on their arrowes, and most dangerous of all nations, of which poyson I will speake somewhat being a digression not unnecessary.

"There was nothing whereof I was more curious, then to finde out the true remedies of these poysoned arrowes: for besides the mortalitie of the wound they make, the partie shotte indureth the most insufferable torment in the world, and abideth a most ugly and lamentable death, sometimes dying starke mad, sometimes their bowels breaking out of their bellies: which are presently discoloured as blacke as pitch, and so unsavoury, as no man can endure to cure, or to attend them. And it is more strange to know, that in all this time there was never Spaniard either by gift or torment that could atteine to the true knowledge of the cure, although they have martyred and put to invented torture I know not how many of them. But every one of these Indians know it not, so not one among thousands, but their soothsayers and priestes, who doe conceale it, and onely teach it but from the father to the sonne. . . ."*

Unfortunately this graphically macabre piece of reporting has no more bearing on the true picture of curare and its action upon its victims than has much of later literature. In fact, Hakluyt's report seems to foreshadow many of the more dubious descriptions of curare which were written during the centuries that followed. Despite the grimness of the "field research methods" imputed to the Spaniards by Sir Walter Raleigh, that doughty gentleman's own description of death by curare is the antithesis of the near flaccidity by means of which the drug actually ends life.

This particular misconception holds in practically all the popular literature and, regrettably enough, in much of the scientific also. Many other erroneous ideas regarding the nature and primitive origins of the drug occur in pseudotechnical literature, in travel stories, and elsewhere. Most accounts, therefore, are hardly helpful when evidence is being prepared and correlated for research in the drug. Likewise much of the excellent work in the chemistry of curare is to a certain degree premised on misconceptions — or possibly on a certain lack of knowledge — regarding the sources and origins of the drug. The active principles of curare consist in the main of grouped alkaloids, highly complex in their chemical nature and interrelationships. Considerable work in the fractional chemistry of these groups has been done, particularly in England and Germany. Much of the value of this study has been lost, however, because the work was apparently done on small amounts of heterogeneous mixtures brought into civilization by wanderers in the South American wilderness who obtained the gourds (sometimes bamboo tubes or small clay jars) of the material without in the least knowing either qualitatively or quantitatively what had entered into the mass. No field authentication was made of the exact botanical ingredients or of the proportions used in these batches of curare, and therefore no predictable duplication could be made of the batches on which such detailed and exhaustive fractional analyses had been based. As a consequence, and until very recently, curare was "scientifically classified" by the *type of container* in which it made its first appearance in civilization. Thus we had pot curare or gourd curare or tube curare — as futile a system, scientifically, as endeavoring, for example, to classify quinine salts by variously calling them pasteboard-box quinine or glass-vial quinine!

Courtesy Henry Holt and Company

Primitive curare is a dark brown to black gummy substance.

The chemical knowledge of curare was further complicated by the fact that, clinically speaking, no chemical fraction of the drug was so good in its physiological effects as were those infrequent batches of "entire" drug which were occasionally used medically. Synthesis of a clinically adequate equivalent of natural curare has so far been impossible.

Even botanical taxonomy is (or at least was) confusing to a certain degree because one of the main groups of curare plants was classified in the *Strychnos* genus. This forgivable, if baffling, error of observation was made by the famed explorer Robert Schomburgk, who was one of the first to correlate an actual plant with an actual batch of curare. Since the action of curare is directly opposite to that of the strychnine group (their respective chemical structures also differ radically), the mistaken nomenclature has given rise to some further fantastic misconceptions.

And certainly from a civilized point of view the work of the witch doctors, the original manufacturers, could hardly be considered a means of predictable production, even though our own production technique was of course finally evolved out of the (*Continued on page 316*)

The blowgun, as we recognize the philosophy of weapons, is remarkably efficient in that it projects sure death, silently and accurately, to an optimum range.

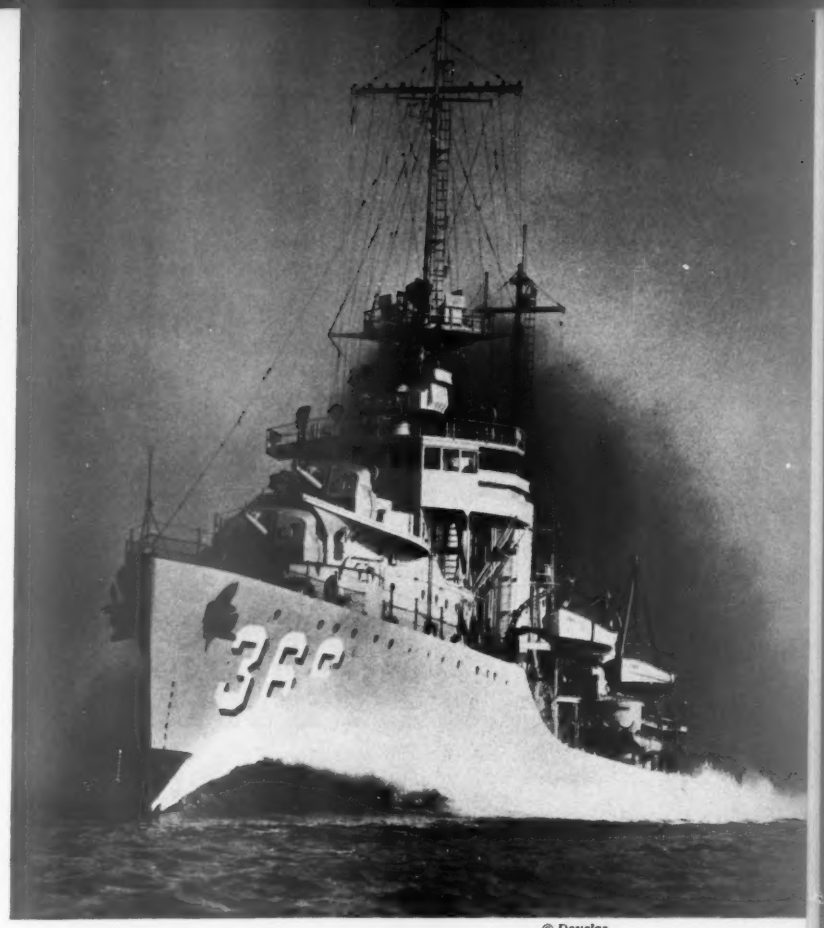
Courtesy Henry Holt and Company

* Richard Hakluyt, *The Principal Navigations, Voyages, Traffiques, and Discoveries of the English Nation* (New York: Dutton, Everyman's Library), VII, 321.

Destroyers

The Mercuries of the Fleet Are Fierce Fighters as Well When Need Arises

By Richard Hallet



© Douglas

Balance, precision, speed . . . a destroyer knifes through the sea on a trial.

NO ships of the Navy have more dash than do the destroyers. I have known some intimately and had a speaking acquaintance with others. They are temperamental ships, having the defects of their qualities. In a hot action they are usually good for only three or four minutes of actual fighting. They must win or lose quickly. Most naval officers, however, think themselves lucky to be assigned to the command of destroyers.

For one thing, their speed is thrilling. As they are often secret-bearing ships, they must have speed. Lord Bacon said: ". . . There is no Secrecy comparable to Celerity; Like the Motion of a Bullet in the Ayre, which flyeth so swift, as it out-runs the Eye." Because of their speed, destroyers are sometimes dispatch boats. In 1928, when I was with the western battle fleet, one of our planes, after being catapulted, fell out of the skies and sank like a plummet beside the battleship *West Virginia*. An hour later the black shape of a destroyer knifed fast across the face of the sun, whose lower limb had already dipped beneath the horizon.

"Going to tell the wives in Honolulu that their men are a thousand fathoms deep," our flight lieutenant said gloomily.

Destroyers, the mercuries of the fleet, can also fight fiercely, as the battle at Narvik showed. Nevertheless, their pecan-shell hulls are not made for resisting cannon fire. It is sometimes said jokingly that boys with air rifles should not be allowed in a yard where destroyers are building. Defensively destroyers are weaklings. Their job is to shadowbox, to provide a screen ahead of the bulldog line of battleships, to nose out submarines and sink them with depth charges.

In the last war, as in this, they convoyed troopships. Some of the destroyers had terrific adventures. Rear Admiral William A. Glassford, now in charge of the Yangtze patrol, once told me of his experience with the destroyer *Shaw* while she was convoying the troopship *Aquitania*. Near the coast of France the *Shaw's* helm jammed. By then, her course could not be changed. The two ships were rapidly converging and must meet. Glassford, then a commander, had two choices: Either he could increase his speed and be rammed himself, or he could slow down, in which case he would ram the great transport amidships.

He chose to increase his speed and be rammed. And he *was* rammed. As a matter of fact, the *Shaw* was cut in two, just forward of her bridge. The *Aquitania's* colossal beak pushed right through everything and out on the other side. The grind of metals threw out sparks that lighted the oil from ruptured tanks. There was a gush of fire round the *Shaw's* lower bridge, and Glassford's first job was to unstrap and throw into the sea a lot of five-inch shells. In the engine room the engineers were desperately shoring up bulkheads; presently Glassford was able to go astern gingerly with his two-thirds of a ship. The *Shaw* had been cut in two so cleanly that the forward third of her actually lived for half an hour. As for the remaining two-thirds, Glassford succeeded in maneuvering it back to the base at Queenstown, a distance of sixty miles, and all the while in the go-astern motion.

He had had plenty of experience with destroyers and knew what tricks can be played with them. Once, on the Eastern station, he had come upon another destroyer stranded on a sand bar in the Yellow Sea. Her commander had lightened her every way he could, but still the full force of her backing turbines was not enough to snatch her off.

A grizzled warrant officer muttered in Glassford's hearing, "A northeast wind would help."

"How would that help?" Glassford questioned.

"Kick up a sea, sir, and she could pull herself off on a wave."

The sea was like a mirror, but Glassford saw how he could manufacture a wave. He swung away through a five-mile circle and then came back at full speed close against the stern of the stranded ship, whose engines, by pre-arrangement, were going full speed astern. Glassford's bow wave ran under her and lifted her, and in those seconds her engines pulled her off into deep water.

I remember in my own experience an occasion when a destroyer took the shape of an angel of mercy. That was in the last war. I was third mate of an army cargo transport, and we were not playing in luck. We were in the war zone, close against the coast of France, when a faulty grease cup stopped our engine for five minutes. We were losing the convoy fast, but the cruiser escort talked to us like a hen clucking to her chick, and we came on again. The going was rough in the Bay of Biscay, and we tossed round like a forty-shilling iron pot. The mate spent his time off watch heaving at the lashings of the airship crates forward, which were slipping loose. The lifeboats, swung out over the water, were also getting knocked loose by the seas. Our compass was out of whack because the Old Man had tried monkeying with the quadrantals while at sea. We didn't rightly know where we were and it was getting dark, with France, a solid and not a liquid fact, just ahead somewhere.

In this plight we fell in with a French destroyer, right against the land. Lean and low, she came oozing up out of a trough with a cocky rake to her twin stacks. From hooks under her pilothouse swayed three or four beeves, glittering with brine crystals. She looked habituated to her job — as if she knew her way around. And she had the insouciant stamp of the free French of those regretted days. She signaled our ship to tail in astern of her and hung out an amber sternlight to help us do so.

That spark was the only light on the French Coast, it seemed to us. The lighthouses had doused their lights because submarines found them useful. With just this faint gleam for a guide, we followed on. The sea was black and smooth this close in. It was my watch, and I kept the ship's prow on that amber light. Suddenly, close aboard on my starboard hand, and standing right up out of the water, appeared a jagged collection of rocks as big as cathedrals. We were at the entrance of Quiberon Bay, which has been the scene of more wrecks and battles than any other bay in the world, but the French destroyer knew her way in, and we crept after her, quaking. I don't know what we should have done if that faint amber gleam had winked out. But it held steady. My friendship for destroyers dates from that entrance into Quiberon.

Some destroyers in their old age have sought service in the Coast Guard. I was on a cruise a few years ago in one of these. The January seas ran high. Besides her straight pitching and tossing, the destroyer had a spiraling corkscrew motion and a rippling caterpillar motion, and then a motion that blended the worst qualities of each. All over the ship were pantings, creakings, slobberings, gurglings, and sounds of like evil omen. Room curtains hung straight out in the alleys, and now and again would come the crash of loose furniture falling down, the ring of dishes and glasses, and other less identifiable sounds telegraphed from distant portions of her struggling and laboring hull. She seemed at times to be flying all to pieces.

One noon, off Block Island, our wardroom lunch was topped off with a savory pineapple whip. Later, with my friend the executive officer, I went up into the wheelhouse. The place was full of a bad smell of burning salt, from spray which had come through loose windows and fallen down on hot steam pipes.

The executive officer said to me darkly: "I am not satisfied with the food on this ship. I think that pineapple whip we had for lunch was made with sour cream."

The cream was actually the very best. The fact is, the executive officer was a seasick man and plunged for the rail, where I joined him. Even the cook in the galley was seasick from the smell of his own food. Destroyers are by nature seasick ships, and even the new ones are no exception to this rule.

A new destroyer is a thing of beauty, even though she may not be a joy forever. When the iron plate that holds her to the land is torched away, six million dollars hang in the balance. The builder is aware of this fact. His hand at her prow, he seems to breathe a prayer and push her back into the tide. The pretty girl with an armful of roses christens her with a bottle of champagne and so prepares the destroyer for a life at sea. In that moment the destroyer slips, slides down smoking ways, and makes her bow to the land. The builder's worries are over for a time. If she had stuck, it would have been a matter of seven weeks to build the ways up under her for a second launching.

But she hasn't stuck. She is in the water with all her flags flying, and presently she is ready for her builder's trials. Yard mechanics, a set of superior ragamuffins with no sense whatever of sartorial elegance, swarm aboard her. This is not navy style, but these men know the engines because they have built them into her. Deck officers say that practically all the nuts are in the engine room, and they may be right. Engineers retort that deck officers are dreamers and stargazers, paradoxically charged with the duty of keeping the engineers from seeing rocks come through her bottom. The engineers are, nevertheless, proud of the destroyer's beauty and bright burnish. They grumble if brass valve wheels are substituted anywhere for stainless steel. A smutted oiler points out that the rails to the bridge ladder are not welded. They can be taken off and put against a buffer in the machine shop, whence they return as bright as icicles.

The screws are turning over now. Deep down in green water, milky clouds are stirred up by the wheel motion, and pour toward the surface. The destroyer gathers speed. Soon she is going fast for the first time. All her thousands of horsepower develop at once, without hitch, as if the ship had been at sea a year. Science has known how to forelay perfectly for this marvel of motion. Nothing has been left out of her, the landlubber supposes. She has neither a nut too many nor a blade too few. She is the last word in modern precalculation.

Now she is "shaking the knots out of her," as sailors say. Her wake is a rooster's tail, a lacy dome of threshed water made by the infolding and braiding and shooting up of the two streams thrown by the powerful screws. Back of this dome is the wake, a seething white band on the blue September sea. Wave shapes are opened out like flower petals by the destroyer's rush. On the starboard beam, a white bird flying close to the water seems to compete with this speed, holds its own for a time, then slips back. The destroyer forges ahead; the bird tosses astern.

A foreman standing near the skids for the depth charges says that he has performed his part of this miracle with a gang of farm hands and clam diggers. These, if they are men of horse sense, do better than men who have a smattering of garage mechanics, for example. The former have nothing to unlearn. Each has his small part to perform. If the threat of war ends, back he goes to his clams. No more of these magic days in the inspirational company of one of the fastest ships in the world, with an engine almost as delicately complicated as a human brain.

The builder on the bridge points out a deck hand with a rag round his finger. "We take the best of care of the men. Their orders are to bring the least infection for treatment. Safety first. We are building a destroyer for wholesale killing, and we must think of the health of our workmen."

Everything is provided for the comfort of officers and crew. Yellow hardwood settees are screwed port and starboard against the deckhouses, so that the men can watch the poetry of the seas. There's a swivel chair for the pilot in the wheelhouse. The ship steers like a charm, with none of the old-fashioned struggle at the wheel. Foolproof devices in spots all but do away with the need for a brain. Even the galley is a work of art. There the chef will take the cover off a thirty-gallon steam-jacketed kettle and show you the king of all fish chowders with a three-pound lump of butter melting in it like the sun trying to burn through a fog. All cooking equipment is electric. No old-fashioned coals to spill out of a stove in a seaway. No coal to stoke in the fireroom either. Even the fo'c'sle head has less grief than of yore. The windlass squad is letting the anchor out in sixty fathoms. A lean fellow in a black shirt crouches, watching the links flee away from the wildcat. He sees the colored link when no ordinary eye can mark it, waves his arm. Instantly the anchor is snubbed, stopped in its plunge. It comes up as easily. A steam windlass does the work. Once this was agonizing, and it took a windlass chantey to get the anchor up at all. Now there is only a group of silent men with watches in their hands, counting the seconds of elapsed time for windlass performance. The song is out of men's throats and has got into the destroyer's boiling compulsions. The music is only the music of the spheres.

In the wardroom, where sheets of brown paper are laid over the transoms and on the new table top, some technicians are lounging around. They are arguing about blueprints, under the eye of a naval representative whose duty will be to accept or reject the destroyer, or at least to make the recommendation to the naval board. The navy man's voice is sharp and accurate; he never hesitates, is never at a loss for a fact or a figure. His naval superiors seem to surpass him only in their possession of a sense of humor and in the fact that they are, after all, older and mellower men, who deserve a certain amount of reverence for their past performances.

The builder's technicians, although not quite so articulate, do not lack a practical grasp of the immense coil of facts that make the functioning of such a ship. The naval authority is alert and prideful, snaps out his judgments, forces the facts to make a pattern round him like iron filings round a magnet. This is his big time. He is certifying a destroyer — an important responsibility. If there is a war, destroyers may average two battles apiece. The average fighting time (*Continued on page 325*)

Douglas

Destroyer 423, U.S.S. Gleaves, built by the Bath Iron Works Corporation, pictured during a trial run

"Them As Has, Gits"

Jet Propulsion, the Rocketer's Delight, Offers a Bonus of Added Speed to Airplanes Which Can Move Fast Enough to Take Advantage of It

By Paul Cohen

AS Buck Rogers' experiences indicate, there's nothing like a rocket ship for getting around. The jets of hot gases from which rockets get their motion are the world's simplest and lightest prime movers — if one forgets the little problems of keeping them continuously supplied with fuel and oxygen. Instead of losing power at high altitudes, as does an internal-combustion engine unless supercharged, a nozzle can be made to increase thrust as air pressure drops. The thrust would reach its theoretical maximum in a vacuum. In fact, Mr. Rogers has chosen about the only device which, even theoretically, could propel him through interstellar space; for, to paraphrase Newton, you can't get anywhere unless you are pushed, and in this respect the rocket is always self-contained. Wherever it goes, it carries with it something to kick it forward — namely, the gases which are blasting backward from the nozzle. Although a nozzle will yield as much thrust when standing still as when moving, for which reason it is being seriously considered as a lightweight auxiliary power source in getting heavily laden planes off the ground, the work it will do per unit of time is obviously directly proportional to the velocity of the nozzle. Thus, a nozzle delivering a 1,000-pound thrust but anchored in a frame, although impressively noisy, is doing no useful work. The same nozzle pushing a rocket forward at 400 miles an hour, however, would be delivering slightly over 1,000 horsepower and would still be far below its maximum output.

Graceful and sturdy, yet limited in diameter and in number of blades, propellers are having trouble absorbing the great amounts of power that present engines can produce.

Raymond B. Collerd, '20

Unfortunately for rocketers and others who would like to make immediate use of jet propulsion, the efficiency of a jet as a propelling means — that is, the amount of work it will do for a given amount of fuel — continues to increase more or less indefinitely with speed. Except for the frictional resistance of the air or other medium through which the rocket ship must travel and the weight of fuel which the ship can accommodate, there are scarcely any restrictions on theoretical top speed and efficiency. Since the thrust of the nozzle remains the same regardless of the nozzle's velocity, the nozzle can continue to accelerate a rocket after the rocket is traveling faster than the gases leaving the jet. These gases, incidentally, develop speeds of 5,000 feet a second and up — a long way up. With efficient fuels — for example, gasoline and iquid oxygen — jet velocities of 12,000 feet a second have been obtained. By comparison, a plane with a top speed of 400 miles an hour, which necessarily spends much of its flying time in taking off, climbing, and cruising at considerably less than top speed, can reach a velocity of only 587 feet a second. Regardless of other difficulties, therefore, and one can mention the metallurgical problems of handling intensely hot gases for long periods of time, the primary barrier to fully effective application of jet propulsion to planes is their present "low" speeds.

Nevertheless, jets of hot air and gases expanding through nozzles are contributing significantly to the performance of hundreds of fast, heavily powered planes now in service. At the moment, these jets are purely auxiliary propelling means, their energy salvaged from the waste heat thrown off by the engine, but since the work these jets will do for a given amount of fuel increases directly with the plane's speed, and since plane speeds are still rising, it is foolish at this time to attempt to define the possibilities of jets.

Of the energy available from the fuel, the modern airplane gasoline engine delivers about a third to the propeller. Somewhat more than a third escapes through

A fast American pursuit plane — the Curtiss P-40 — in flight, its external ducted radiator on display

Curtiss-Wright Corporation

the cooling surfaces, and the remainder is discarded in the exhaust. The engine designers find that they must pay just to lose energy: Cooling systems add materially to weight and cause a very substantial drag; exhaust manifolds add weight, create a hazard, and cause some drag. As engines get bigger, speeds higher, and planes cleaner, the radiator surfaces become an increasingly important source of air friction. Perhaps 5 to 10 per cent of the power of a fast plane may be spent in dragging the radiator through the air.

One means of salvaging a portion of the energy escaping with the exhaust has been available for some years. This is the exhaust-gas turbine, almost invariably used to drive a supercharger. First applied on marine Diesel engines, the turbine-supercharger unit has several strong features to recommend it. No additional horsepower and therefore no additional fuel need be expended to compress the intake air. Because the turbine, like the supercharger, is a high-speed device, the two can be coupled directly together. Since the turbine spins faster as the air pressure drops, it will give a stronger supercharging effect at higher altitudes, where it is needed. Nevertheless, the high temperatures of the exhaust gases create such severe conditions for the blades that not all consider the turbine to have the reliability required for aviation duty, and the superchargers for many engines are still gear driven, at a cost of perhaps 150 horsepower for a 1,000-horsepower engine.

With gear-driven superchargers the exhaust gases, amounting to perhaps 130 pounds a minute for a 1,000-horsepower engine, may still be utilized, and in a most direct and simple way. By relatively minor changes of the manifolds, the gases are made to escape in a rearward direction through nozzles which expand the gases down to atmospheric pressure and in so doing greatly increase their kinetic energy. A forward thrust is thus created, and for ships flying at 400 miles an hour a 6½ per cent increase in maximum power is claimed, equivalent on some planes to an increase in speed of from ten to twelve miles an hour. Such exhaust ejectors are now being installed on a majority of British service planes and on many American models. Further increases in speed should follow improved manifold design and higher back pressures. Although raising the back pressure lowers engine output, it appears that the maximum total power from engine and exhaust jets at high speeds will be reached at levels of back pressure higher than those used at present. But, as previously pointed out, speed is of the essence. For speeds under 350 miles an hour and horsepowers less than 1,000, exhaust ejectors appear of little value. "Them as has, gits."

About the only drawback to the use of exhaust ejectors is the glare of the escaping gases, which tends to blind the pilot, particularly during night flying. If the manifolds are surrounded with a duct of cooling air, however, as they frequently are in order to lower their temperature and therefore the rate at which their thin-gauge walls are corroded, the glare is reduced and an added thrust obtained. The cooling air, entering through a diffuser, is somewhat raised in pressure. It is then raised in temperature by the hot surfaces of the manifold, and finally is expanded through a nozzle, leaving the duct with more momentum than it had when it entered.

The principle involved is precisely the same as that now utilized in ducted radiators. In 1935, F. W. Meredith pointed out the possibilities for increased performance residing in the fact that if air is admitted into a duct at high speed, slowed down (and therefore raised in pressure) by means of a diffuser, heated, and then expanded to its original pressure through a nozzle, it leaves the duct with greater momentum than it had on entering. In other words, a thrust results. These conditions are found ready made in the radiator units for liquid-cooled engines. Since the drag of an object increases with the square of its (*Continued on page 324*)

Craftsmen at Work

Sketches from the Records of a Medieval Home for Aged Workers Are an Iconography of Trades

By Leroy L. Thwing

THAT a sketch is better than a many-worded description, or that a picture of a workman's tools tells more about them than does an enumeration, is unnecessary to explain to engineers. Such pictures were never common, however, until the development of photoengraving processes. Those few which do exist are, therefore, of unusual interest. Prior to the so-called *Book of Trades* — two of which date from the Sixteenth Century — pictures of a craftsman working at his trade are extremely rare, except for those which come from Egypt and are two to five thousand years old. The Egyptian pictures have been preserved because they are cut, carved, or painted on stone surfaces of such size that they are not easily defaced or destroyed. Similar pictures may have been drawn, painted, or woven as prolifically on less durable materials during the first thousand years of Christendom, but almost none have been found.

Such pictures as we have from the Eighth Century to the Fourteenth Century are the illuminations and miniatures from the manuscripts of the period. Most of these are on religious subjects, and pictures suggesting crafts — even pictures of Noah building the ark — are hard to find but do exist. From this period also come a few engineers' sketchbooks, such as that of Wilars of Honnecourt, but none of them has pictures of workmen and their tools.

With the exception of Egyptian and Assyrian wall paintings and carvings, the oldest collection of pictures of craftsmen at work at their trades is found in the records of a Fourteenth Century German home for aged workmen, the Mendel Foundation at Nuremberg. The home was founded in 1380 by Konrad Mendel as an asylum for twelve old, but not incapacitated, craftsmen. In the 167 pages of the manuscript are sketches of about three hundred "brothers," dating from 1380 to 1535. Unfortunately the first four pages of the manuscript are missing, but there are several sketches from the Fourteenth Century. With each is a notation of the brother's name, number, trade, and the year of his death. This valuable manuscript is preserved in the Stadtbibliothek at Nuremberg. A few of the sketches have been reproduced by F. M. Feldhaus in *Die Technik der Vorzeit . . .* and in other of his instructive publications on the history of tools and utensils.

One of the oldest of the sketches (Fig. 1) is that of the sixteenth brother, a thimble maker, or *Fingerhuter*, who died about 1382. He is pictured with a pump drill, boring out the little sockets in a thimble. For the operation of this drill the shaft was turned a few times by hand to twist the cord around the shaft, thus lifting the crossbar. When the operator pressed down sharply on the bar, the cord untwisted and rotated the drillshaft. The momentum of the cup-shaped flywheel wound the cord again, and the drilling proceeded rapidly, cutting small holes. This type of drill was described as early as the Eleventh Century and is still used to drill china and porcelain.

Three wiredrawers, or pinmakers, died at the home, and the three sketches of them illustrate as many different methods of wire drawing. The first (Fig. 2) shows a workman pulling heavy wire from a coil through a series of holes in a steel drawplate. Note that he is seated in a swing, which permits him to draw two or three feet of wire without shifting his grip with the tongs. Details of this sort inspire our confidence in the artist who portrayed them. The next sketch (not shown here) illustrates the second process: the wire being drawn through another plate onto a spool. The final drawing (Fig. 3, about 1396) was by stretching only; no drawplate was used, doubtless for fear of breaking the wire, which could not have been of

1. A thimble maker. 2. A wiredrawer. 3. Final drawing of wire. 4. A joiner. All from Feldhaus' Die Technik der Antike . . . , *copyright Akademische Verlagsgesellschaft Athenaion.*

uniform texture. The art of wire drawing is much older than any sketches, but these are the oldest pictures showing the process which have survived the hazards of time.

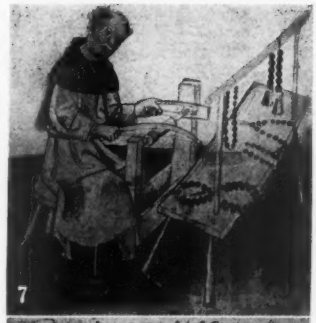
In Fig. 4 a joiner is at his bench with its stops, planing a plank. His position and that of his right leg suggest that some liberties have been taken to make the artist's task easier. The plane and saw are types used for hundreds of years both before and after 1400. The blade of the saw is tightened by a twisted rope. The chisel is made in typical medieval pattern. The chest with its fleur-de-lis strap hinges and the small cupboard are the oldest pictures of such furniture known to the writer.

The men shown in Figs. 5 and 6 are pewterers. The first shows the casting of a flagon, or the removal of one that has already been cast from the lower half of the mold. (These operations were naturally not simultaneous.) The square pit in the floor is presumably filled with molten metal. In the other portrait the finishing process is shown. This involved rough turning with a hand tool and finishing with a burnisher to remove the toolmarks. (The man who used the tools is not shown.) This kind is typical of early lathes for turning fairly good-sized work. Bells were finished on similar lathes. Wood was turned on a pole lathe, such as that illustrated in the January, 1933, Review (page 135). One of the brothers, who died in 1395, was a turner, but his picture has never been reproduced.

A lathelike device is shown in Fig. 7. This is a *Rosenkranz*, or rosary maker. The cutting tool, a combination drill and hollow mill, is rotated by the bow. As the tools probably cut equally well in both directions, the work progressed quite rapidly. The headstock of this lathe is fixed; the footstock is pivoted at the bottom and, being pressed by the operator's knee, feeds the tool into the work. The first operation is to drill a hole through the stock and, at the same time, mill out half of the bead. After one side has been completed, the strip of wood is turned over and the other halves of the beads are milled out. They may have been finished on an arbor with sharkskin or shave grass. It is said that the Dutch in New York set up lathes to make wampum to trade with the Indians. If so, the beads were probably made by a similar process.

A forgotten trade is that of the horn breaker, illustrated in Fig. 8. The tip was sawed from a cow horn and the hollow remainder split along one side. This was soaked in hot water and held over a bed of charcoal, which softened it so that it could be split into thin sheets for windows and lanterns. These sheets were flattened between two boards in the press shown in the foreground. The pressure is by wedges. Figure 9 shows a ropemaker at work. The apprentice who put the twist into the rope is not shown. Figure 10 is a *Schlosser*, of which the nearest English equivalent is a locksmith. Here he is filing a lock held in a vise tightened by a screw. The wrench is lying beside it. It will be noted that he is holding his file with the thumb *up*, in the manner taught to generations of Technology men by the late well-remembered "Pop" Smith.

These pictures of medieval craftsmen are unique. It is doubtful if anything as good will be found in the future. The artist who drew these sketches lived with the men he portrayed, and many little details show that he watched them at their work. Later artists were farther removed from workshops, and some of their technique is questionable, but these Fourteenth Century "portraits" carry conviction of their accuracy. We are fortunate to have them.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5, 6. Pewterers. 7. A rosary maker. 8. A horn breaker. 9. A ropemaker. 10. A locksmith. Figures 6, 7, 8, and 9 from Feldhaus, copyright Akademische Verlagsgesellschaft Athenaion.

A Pile Driver's Respects

The Practicing Engineer's Curiosity about Technical Education Should Be Given Direct Expression

By Edward H. Cameron

IT is good logic to make a generalization and then to give the exceptions which limit it. Thereafter we may examine the exceptions, and, if they appear top heavy, we may revise the generality into something on which everybody should agree. Let's try this yardstick on the matter of how well the teachers in the schools and the engineers in the field are working together. Mutually complimentary relations exist between the two groups. The professors pay the practitioners the high compliment of a deep interest in their accomplishments. To this the practitioners respond with a modicum of curiosity in the pedagogical methods of the schools — which is appreciation to a superior degree, when you stop to think. So everybody is happy. Dangerous generalizations, however, must be promptly hedged in with many limiting qualifications if misunderstanding is to be avoided. We must state, therefore, that the interest of many teachers in manufacturing and construction developments comes from their personal concern in those developments, through consulting or administrative activities. And many engineers in active practice show deep concern in educational affairs, often occupying chairs in the schools. Furthermore, there may be some men in practice who are not content with the training of the young men who come to them from the colleges.

If the foregoing exceptions seem sufficiently heavy to endanger the generality, let us revise it. Everybody ought to agree that engineers in active practice should, by greater concern in scholastic matters, reciprocate the interest which the schools show in practical affairs. The practicing engineer's curiosity should be more earnest than that satisfied by a casual glance at the monthly alumni journal, and might well equal the deep concern which is immediately apparent when some alma mater's coaching staff slackens its efforts. The latter event often causes as much distress as the receipt of a carload of poorly fabricated steel. In both cases, the conclusion is that the offending shop should catch hell, as is proper.

Delinquency, though, is a serious charge, and it is in order that we engineers mend our ways. Let us adopt the useful dodge of taking the offensive by coming through with a few suggestions as to what we think ought to go into the making of a good engineer. What should the professors teach our future assistants?

First, consider the target practice. The ancient definition — schools are where the young idea is taught how to shoot — still holds. School targets are necessary, but they must be man-size ones. The ambitious student, as might be expected in this age of increasing ranges and velocities, demands at least a few pot shots at the often poorly defined and unstatic objectives that he knows must be scored on with reasonable accuracy later in his professional career. Practical subjects, we mean. The anchored targets of classroom range, secured by the careful suppression of gyrations due to factors that won't stay put in practice, are not sufficient.

But there's a limit to all things, and the instructor might feel justified in saying: "This school teaches the fundamentals of mathematics and other sciences, and the Good Lord knows that the knowledge thereof has become complicated enough. You'll thank us, ten years hence, for sticking to such fundamentals and agree that the practical training was properly left to the teachers who took you in hand upon your graduation. A pile-driving foreman, to whom Hooke's law has the ominous savor of a magistrate's court, can demonstrate to you in fifteen minutes such practical matters as how accurately a pile can be driven to plan dimensions. Our job is to teach you how many piles to drive, to what refusal they must be driven, and how to interpret the borings so that you may arrive at the proper decision in such problems."

To which the young man would politely say, "Nuts!" and his daddy, who is paying the bills, would back him up.

Thus a principle that many consider eminently sound, in view of the tremendously complicated state to which engineering science has advanced, has had to give way to educational concepts of a much wider scope. Others say that this is all to the good and that engineering education must not remain tied to the hitching post of the horse-and-buggy era. We outsiders don't know the answer to this one, of course. But we must agree that juvenile skulls have needed some forced culture to keep up with the procession in a generation or two of cranial evolution. In the language of the poet, slightly paraphrased, "still the wonder grows, that one small head can carry all he knows."

But we respect him! Older engineers, who, like the writer, have attended twenty-five-year reunions, are sincere in their respect for the scientific knowledge evinced by recent graduates (*Continued on page 318*)

Practitioner and Professo Disc

Sublicariis Aliisque

Curricula Can Be Adapted in Various Ways to Meet the Needs of the Times; One Method Is Analyzed

By William H. Timbie

I AM glad Mr. Cameron used a Latin expression in his article on the opposite page, for he thus affords me an excuse to use a Latin title and give a sort of Classical flavor to a matter-of-fact account of one solution to the problem which he presents. This is the first practical use I have found for the long hours spent in the study of the language of Cicero and Horace. At that, I must confess I had to build up that word for "pile drivers." Apparently the prefabricated form was not on the Roman market.

Alumni interest in the policies of alma mater I don't doubt exists in plenty, but actual expression by an alumnus of interest in the educational policy and methods of the institution from which he was graduated is rare. Most alumni are concerned with the results only, and from time to time give us reports on the quality of our product, either raking us over the coals because the quality has deteriorated or praising us if they find an improvement.

Mr. Cameron's main thesis is that by some educational process the teaching staff ought to keep up to date in practical applications of the engineering principles which it is trying to teach, and in some way see that the students appreciate the connection between application and theory. Recognizing the fundamental difficulty which a school would encounter if it tried to teach an adequate amount of both theory and practice, he laments the failure of the schools effectively to attract the attention of the alumni to new educational methods, introduced as a result of changing industrial conditions, and to the educational principles underlying these changes. I agree with him as to the scarcity of this kind of information that actually gets across to the alumni. I also appreciate the great advantage which would accrue to a school if it could keep its alumni interested in, and informed on, these matters. After all, the greatest concern of an educational institution ought to be its educational principles and methods. Oddly enough, an educator loves nothing more dearly than to talk and write about the improved educational processes of his institution, but listeners are few, and readers — about the magnitude of the *n*th term in a vanishing series. Now along comes Mr. Cameron actually asking for it. The chance is too good to pass up; I'm going to have one reader anyway.

It was realized from the beginning that however well grounded in theory a technical graduate might be, he could not tackle effectively the engineering problems of industry until he had also become familiar with current industrial practice. Accordingly, upon graduation a student usually entered an industrial organization as an apprentice. During this period the student's engineering training lay more or less dormant, however, and much of it was forgotten. As an engineer would say, there was too much slack and lost motion in the arrangement. It was evident that a student ought to be getting his undergraduate practical experience while acquiring his undergraduate theoretical education. The first attempt to combine the two was to transplant into the engineering schools representative specimens of industrial equipment and even of industrial production.

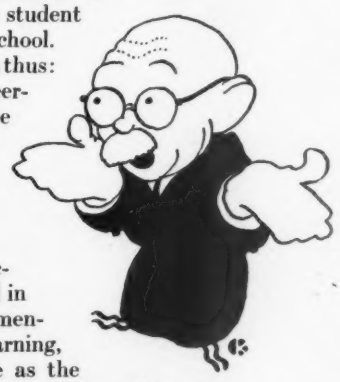
This policy was found to have several defects:

(1) The initial financial outlay would be extremely high if anything further than the fundamental shops were to be equipped.

(2) In a rapidly expanding industrial era the cost of keeping machines and processes up to date was prohibitive.

(3) Maintenance of the necessary industrial atmosphere was almost impossible in a school shop.

(4) It was necessary either to abbreviate greatly the theoretical content of the curriculum or to lengthen the time which the student would be required to spend in school.



Hence the problem boils down thus: A young man goes to an engineering school solely for the purpose of acquiring the scientific habit of thought and knowledge of the principles and theories underlying modern industrial progress, because it is extremely difficult for him to acquire them while he is employed in industry. But one of the fundamental principles of the process of learning, almost as universal a principle as the law of gravitation, is that no one can thoroughly grasp the meaning of an abstract theory until after he has had concrete experiences in its application. If the school takes the time to afford the student these necessary experiences, he must either go without much of the very education for which he came to the school or else remain in school a considerably longer time. It looked very much as though the embryo engineer just had to have his educational cake and eat it too.

Unsolvable as the problem appears to be, several effective solutions have been worked out, one of which is the co-operative plan. Probably because for the past twenty years I have been (*Continued on page 320*)

Discuss The Teaching Task

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Harold E. Edgerton, '27

LEVITATION OVER WATER

This high-speed stop-motion photograph of David W. Howard, '41, captain of Technology's swimming team, who holds the national junior amateur high-board diving title, attests to the popularity of swimming, made possible by the facilities of the Alumni Pool Building. The photograph was made at the New England Intercollegiate Swimming Association championships held at Technology in March.

First Figures

ALREADY to Alumni has gone a preliminary report on the first year of the M.I.T. Alumni Fund, as of February, 1941, surveying the record that, four months before official closing day, had assured the success of the Fund as an annual activity. More Alumni have participated, the report shows, than in any previous fund- or dues-raising activity. On February 28, the date of the preliminary survey, 7,666 members — a quarter of the entire Alumni body — had approved the aims and methods of the Fund by means of their contributions. Total received to that date was $60,991.21, an average contribution of $8.49. Almost two-fifths of the total goes directly to the Institute for continuing projects, for student recreational facilities, and for free use under the direction of the Alumni Fund Board, of which H. B. Richmond, '14, is chairman. This auspicious start points to a future importance for the Fund well summarized by Mr. Richmond thus: "If precedent is a guide, the ultimate results of the Fund plan will be instrumental in keeping Technology in its position of leadership in the scientific educational field."

"Our American Tomorrow"

BROADCASTING over the network of the National Broadcasting Company on March 15, President Compton looked into the future, to see what may be scientifically in store for Americans. His address was as follows:

"Just to get started in our thinking about America tomorrow, suppose I begin by asking myself two very simple questions. For example, I ask, 'Where will Joshua Smithers be tomorrow?' Well, if I knew anybody of that name, and knew where he is today, and knew in what direction he is going and what is his method of transportation and something about his habits, I might make a fairly reliable answer to the question. But since I know absolutely nothing about Mr. Smithers and do not even know whether such a person exists, any answer which I might attempt would be worthless.

"But if I ask myself the same question about my friend Bradley Dewey ['09], I can give a much better answer. I know that he stopped in Washington yesterday and left today by automobile for St. Louis. I also know that he is an intelligent and purposeful man and a skillful driver. I feel very certain that tomorrow he will be well along his way to St. Louis. There is, of course, the chance that he may have changed his mind or had an accident with his car, but the chance of his not being well on the way to St. Louis is very small.

"In this same spirit, I believe that an intelligent answer can be given to the question, 'Where will our America be tomorrow?' — meaning, of course, five, ten, twenty-five years from now. We first need to know where America is today, in what direction she is going, what forces are taking her along her path, and what is her character.

"Starting with today, we know that America is, in most respects, the envy of every other people on earth. Often we find fault with this or that condition in our country. But any useful judgment of America today must consider practical standards of comparison, and by the comparison with any other part of the world we have sound reason to be thankful and to have faith in the future.

"Natural resources? The most varied and abundant of any nation. Comforts of life? By all physical standards — such as heated and lighted homes, silk stockings and fur coats, automobiles and refrigerators, movies and radio, medical care and food supply — far ahead of any other people. Freedom of speech and action? Where else in the world today can you come as near to saying what you think or doing what you please — as long as you act decently; or where can you go ahead just as far as your ability and luck will take you — even granting that these situations are not perfect? So I submit that America starts today in a situation that should give us real confidence in tomorrow.

"In what direction is America going? Look for a minute at a few typical facts. The great chemical industry of our country, which vitally and beneficially affects almost every aspect of our lives, has, practically

As a diver goes up and over, facial expressions of onlookers at a recent swimming meet at the Alumni Pool run the gamut from obliviousness to amazement. Standing by the microphone is Arthur H. Sweeney, Jr., '42, manager of the swimming team, whose conduct of the meet brought him much commendation.

Louis Rosenblum, '42

speaking, come into being only during the twenty years since the World War. Rayon, nylon, plastics, safety glass, antiknock gasoline, dyestuffs, and innumerable medicines are only a few of its products. Through successful research and wise management it continued to grow even through the recent depression. We can see no limit to further progress in this direction. The electrical industry tells a similar story, which you all know.

"Thirty years ago we should have called fantastic any claim that by today we would be talking, without wires, from Australia to New York; that a person in Chicago could clearly see his friends in New Orleans; or that commercial flying machines would be carrying a significant part of the passengers and mail traffic of the country. Yet here we are, doing these things almost as a matter of course and doing hundreds of other new things as well, and some millions of men and women are earning their living by making or selling or operating all these new creations of science. Simultaneously, by enslaving coal and steam and water power and machines, our human toil has been lessened to a standard of forty hours a week, the earnings and production from our toil have multiplied, we have been able to afford some social security. Also we have shared more wealth, not so much by taking it from the rich and spreading it around as some people think, for that would be but a drop in the bucket, but by creating more. The wealth that has been shared far and wide and is being shared still further is almost entirely wealth which has been actually created by brains with the help of machines. In other words 'technological progress' is the phrase which epitomizes the direction in which America is going.

"What will our America be like tomorrow? I look to see a race of Americans made healthier by medical progress and better living conditions. I look to see them gainfully employed in industries now undreamed or only in the embryo stage. I look to see more wealth distributed, not by taking it away from someone who has a good share, but by creating it — for that is the proved way of science. I look to see people living in homes of new designs, of greater convenience and attractiveness, based on new structural materials and methods, and located in groups planned for effective community life. I look to see great cyclotrons operating as chemical factories instead of laboratory instruments. I may see great power plants in which the fuel under the boilers need not be replenished in a thousand years. I shall certainly expect to see rain and fog eliminated from the list of hazards to travel by sea or air. These are only a few samples of what America's future looks like to me.

"Thus can we predict our American tomorrow from our knowledge of America's position today and the direction in which she is going. You may have noticed that I have omitted one stage in the analogy with my friend who is on his way from Washington to St. Louis. In addition to knowing his starting point and direction, I had to know something about his *character*, or all else would have been useless in predicting his course. Had he been weak or vacillating or thoughtless, I could not have been at all sure where he would be tomorrow.

"So, back of America's position and progress lies America's *character* as the factor on which our American tomorrow depends. This means *your* character, and mine, and our neighbors' all over this land. Are we willing to pull together, like a well-trained and disciplined crew, to carry out effectively the majority will of our people as made known through our democratic processes of election and free speech? Are we farsighted and determined enough to make today the sacrifices necessary for safeguarding America and to plan intelligently and work hard for America tomorrow? Have we will to resist that selfish and most vicious of all tendencies to try to get something for nothing by class legislation or by crooked dealing, instead of holding to the good American doctrine of fair play and a fair reward for honest work? Have we wisdom to handle our good heritage and courage to defend and improve it? I believe we have, and that is why, despite temporary and grave problems which we face today, I can feel an optimism and an enthusiasm about the American tomorrow in which your children and mine will live and which you and I are trying to safeguard and improve for their sakes."

Graduation

ROBERT E. WILSON, '16, President of the Pan American Petroleum and Transport Company and former director of the Institute's Research Laboratory of Applied Chemistry, will make the commencement address at the Institute's seventy-fourth graduation exercises in Symphony Hall, Boston, on June 10.

Dr. Wilson was graduated from the College of Wooster, in 1914 and he was awarded the honorary degree of doctor of science in 1931. After his graduation from the Institute in 1916 with the degree of bachelor of science, he was appointed a research associate in applied chemistry, a post which he left in 1917 to serve as consulting chemical engineer for the United States Bureau of Mines. Later he was commissioned a major in the Chemical Warfare Service and was placed in charge of research on gas absorbents. Returning to Technology in 1919, Dr. Wilson was made director of the Research Laboratory of Applied Chemistry in 1920 and later was appointed an associate professor of chemical engineering. In 1922 he joined the Standard Oil Company of Indiana, where his work in research and development led to the post of vice-president from 1931 to 1934.

This year's commencement exercises will be broadcast from Station WMEX (1510 kilocycles) from 11:00 A.M. to 1:00 P.M., eastern daylight-saving time.

The baccalaureate address to the Class of 1941 will be given by Anton J. Carlson, the distinguished physiologist who from 1909 to 1940 was professor of physiology at the University of Chicago. Dr. Carlson was graduated from Augustana College in 1898 and was awarded the degree of doctor of philosophy by Leland Stanford Junior University in 1902. He is a member of the National Academy of Sciences and a former president of the American Physiological Society.

For Public Safety

MEETING on the last day of March for its 219th session, the Alumni Council had members of the Faculty Club as guests and three representatives of the Massachusetts Committee on Public Safety as speakers.

After an expeditious business interval, including a highly attractive advance report from Richard Whiting, '26, chairman of Alumni Day 1941, President Henry E. Worcester, '97, introduced John W. Farley, '98, executive director of the Massachusetts Committee on Public Safety, who explained the problem of the organization of civilian defense and described the division of work which the committee has set up. The situation in America today, he said, has no precedent, and the idea of minutemen springing into action overnight is out of the question. Preliminary precautions are essential, and the length of time demanded to get civilian defense measures in force may be gauged from the fact that over three years were required for the civilian organization in England to become established.

Daniel Needham, director of the protection division of the committee, considered specifically one aspect of the general situation which Mr. Farley had outlined. Describing the successive steps involved in dealing with air raids in England, General Needham stressed the importance of the large trained and organized volunteer personnel imposed by the requirements of an effective air-raid precaution system.

Violet M. M. Mason, a teacher in the Wellesley public schools, who was a student at Oxford University last year, rounded out the speaking program by giving a firsthand account of what air raids mean to the civilian. Speaking from her observation of raids in Oxford and London and from her study of civilian activities there and in Paris, Miss Mason confirmed the general assertions of Mr. Farley and the specific recommendations of General Needham concerning the necessity both for organization and for promptness in getting such organization started.

Summer Programs

THE need for specialized training in science and engineering for many governmental and industrial defense activities gives added importance to the Institute's comprehensive programs to be offered this summer. They include spectroscopy; principles of textile analysis; food technology; principles, techniques, legislation, and administration of city planning; public health, school health, and health education; and public-health engineering. Special conferences are to be held also on photoelasticity; powder metallurgy, and vibrations. Those students qualified for special and graduate subjects will have opportunities to pursue individual work in many of the Institute's well-equipped laboratories as well as to participate in the formal programs.

The summer conference on spectroscopy and its applications will be held again this year from July 21 to July 23. Also, courses in practical spectroscopy, applied spectroscopy, and quantitative spectroscopic analysis will be held. The first will deal with the design of spectroscopic apparatus and its application to special problems in astronomy, biology, chemistry, physics, medicine, metallurgy, and engineering. The second will treat the use of spectroscopic equipment in problems associated with the fields covered by practical spectroscopy. Quantitative spectroscopic analysis is a short course designed particularly for those interested in the application of quantitative spectroscopic analysis to industrial problems. These courses will be given between June 16 and July 25. The program is in charge of George R. Harrison, Professor of Physics.

Beginning on July 28, the program on principles of textile analysis will be given under the direction of Edward R. Schwarz, '23, Professor of Textile Technology. This comprehensive course includes lectures and laboratory exercises on the principles of textile analysis as related to fabric, yarn, and fiber structure. Microscopical as well as physical analyses are to be covered.

The program in food technology, which is to be given between June 30 and July 18 under the direction of Bernard E. Proctor, '23, Associate Professor of Food Technology, will include lectures, laboratory work, and reports on the manufacture, processing, transportation, packaging, and laboratory control of foods and food products. Selected phases of the dairy, meat-packing, refrigeration, canning, baking, fishing, and beverage

Harold E. Edgerton, '27

Fish's-eye view of a diver slicing into the Alumni Pool, as photographed at high speed through the underwater observation window

industries will be studied, with particular emphasis on the special technical problems which each of them involves.

The program on city and regional planning, which is sponsored by the Institute's School of Architecture and the American Planning and Civic Association and is to be held from July 7 to July 25, will be directed by Frederick J. Adams, Associate Professor of City Planning and head of the Course. Principles of planning will cover the objects and scope of city and regional planning and the elements that make up a comprehensive plan for the physical development of a city or region. Specific problems to be discussed will include transportation, housing, recreation, and zoning. The course in techniques of planning is designed to present the procedure followed by the planning technician—procedure including the surveys, preparation of the plan, and the problems involved in its execution. Planning administration will cover the principles of organization and administrative procedure in the carrying out of comprehensive plans and zoning ordinances.

The public health, school health, and health education program is offered to professional public-health and school-health workers. The program was arranged as a series of summer sessions, the first of which was given last year. This year's course, to begin June 30, under the direction of Clair E. Turner, '17, Professor of Biology and Public Health, will cover pathology, health education, and personal hygiene and applied nutrition.

Because of the many problems encountered in the mobilization of military forces and the concentration of civilians working on national defense projects, the Institute's program in public-health engineering, which begins on June 16, is of special interest. Candidates for this course should have basic training in biology and chemistry. The program will include sanitary biology, sanitary bacteriology, and sanitary chemistry. Civil and military sanitation will be dealt with in lectures, discussions, and field work treating of public-health engineering activities, including water purification, sewage treatment, refuse disposal, milk and food sanitation, as well as camp sanitation and other problems encountered in this field. Modes of infection, insect and rodent control, as well as housing will also be considered. The program will be in charge of Murray P. Horwood, '16, Professor of Bacteriology and Municipal Sanitation.

Staff Appointments

GEORGE C. MANNING, '20, who served as associate professor in the Department of Naval Architecture and Marine Engineering in 1938 and 1939 and who had previously lectured in that Department, will rejoin the staff next September as an associate professor. He was graduated from the United States Naval Academy in 1914 and was awarded the degree of master of science at the Institute in 1920. Since 1933 he has been inspector of naval material in the Boston district.

James M. Austin, who joined the staff of the Institute as a research assistant last year, has been appointed assistant professor of meteorology. He is a native of Dunedin, New Zealand, and was educated at the University of New Zealand, from which he received the degrees of bachelor of arts in 1935 and master of arts in 1936. After a teaching assignment in a New Zealand high school, he was appointed a meteorologist in the Apia Observatory in Western Samoa.

Another appointment to the staff of the Department of Meteorology is that of Margaret Whitcomb, '39, who becomes an instructor. Miss Whitcomb was awarded her master's degree in science last year and has been a research assistant in her Department.

Nathan R. George, 1864–1941

NATHAN R. GEORGE, who until his retirement in 1936 had been a member of the teaching staff of the Department of Mathematics of the Institute for forty-five years, died on March 26. Born in Mendon, Mass., in 1864, Professor George studied at Phillips Exeter Academy for two years and entered Harvard University in 1885. Two years later he transferred to Worcester Polytechnic Institute, where he studied civil engineering for a year before returning to Harvard in 1888. In 1890 he was graduated from Harvard with the degree of bachelor of arts *summa cum laude* and highest honors in mathematics, and a year later he received the degree of master of arts. He was appointed to the staff of the Institute in the autumn of 1891. He was promoted to the rank of assistant professor in 1906, associate professor in 1913, and professor in 1935.

Best of the Year

IN the annual awards of the Academy of Motion Picture Arts and Sciences, recently announced in Hollywood, the motion picture *Quicker'n a Wink*, which shows applications of the high-speed method of photography developed at the Institute by Harold E. Edgerton, '27, and his associates, Kenneth J. Germeshausen, '31, and Herbert E. Grier, '33, was chosen the best one-reel subject of the year. *Quicker'n a Wink* ably demonstrates the possibilities of clear and entertaining interpretation of the achievements in science and engineering. The picture has been shown in theaters throughout the country and has already been seen by several million people.

Typographer

FIFTEENTH Century craftsmanship has been brought to life at the Institute in the creation by Dard Hunter, Jr., of the font of type displayed in the specimen page reproduced on page 313. Employing punch, matrix, and sliding mold in the technique of Gutenberg and his contemporaries as Douglas C. McMurtrie, '10, described it in The Review for November, Mr. Hunter has been at work on the design and production of this type over a period of five years. Its first showing was in the page here pictured, which was published from the Dard Hunter Paper Museum Press in a limited edition of a brochure entitled *A Specimen of Type: An Experiment in Typefounding by Employing the Same Methods and Materials Used During the Earliest Centuries of the Craft.*

Mr. Hunter, who is associated with his father in the conduct of the paper museum, cut the first punch for his type in 1936, when he was a student in the Cleveland

School of Art, under the guidance of Professor Otto F. Ege. The design of the letters seeks to recapture some of the spirit and quality of early type faces, particularly of those found in the incunabula. In the process of manufacture, each letter is cut backward in full size in the end of a steel bar. The bars, hardened, constitute letter punches, each of which is struck into a strip of copper, which forms a matrix. The actual printing types are cast in a hand mold, into which the matrix is fitted.

Before the type is again used, Mr. Hunter plans to recut various characters and to rejustify some matrices, seeking thus to bring the type still nearer to possessing, as the foreword to his brochure puts it, "some of the elusive characteristics that are so pleasing in many of the volumes produced during the first century of printing." How near some critics judge him to have come already is indicated by a statement of Edward Larocque Tinker in the New York *Times*, who describes the new type as "virile, handsome, agreeably archaic and full of character."

Active Museum

THE Committee on the Technology Museum has recently presented a series of notable exhibitions revealing the rich resources of the Institute's various permanent collections as well as the broad scope of material which it is Technology's good fortune to have on loan from time to time.

On March 2, at a tea and private view given by the Friends of the Library, treasures from the Institute's Library, and marine water colors and rare Japanese whaling prints from the Forbes collection were exhibited. The water colors represented the best examples and the largest collection of the work of Benjamin Russell of New Bedford, whose portraits of ships were the fashion of the day among shipowners and ship captains. The exhibits of the Institute Library included the library of an engineer a century ago, showing books used by Loammi Baldwin, a Revolutionary officer and chief engineer of the Middlesex Canal. Other volumes marked milestones in the development of science, and there were a number of volumes on ships and sea lore from the Arthur H. Clark collection. The potter's art was represented by books and specimens. The Central Library contributed famous books and first editions on electricity and magnetism, historical prints and posters showing balloon ascensions, and books on the early history of charts and navigation. The humanistic aspects of an architectural library were shown in an excellent exhibition in the Arthur Rotch Library of Architecture, while the Dewey Library presented working collections of books on economics, business administration, industrial relations, and engineering subjects. Visitors to the Francis Russell Hart Nautical Museum were shown the large collection of ship models and other marine exhibits, including the Henry P. Kendall whaling collection. Special exhibitions of paper and papermaking and the graphic arts were shown in the Dard Hunter Paper Museum, and a supplementary exhibition of front-page typography, an exhibit from the American Institute of Graphic Arts, was displayed in the Main Lobby.

CASTRA·SVNT·IN·ITALIA·CONTRA·POPVLVM·ROMA
NVM·IN·ETRVRIAE·FAVCIBVS·CONLOCATA·CRESCIT
IN·DIES·SINGVLOS·HOSTIVM·NVMERVS·EORVM·AVTEM
CASTRORVM·IMPERATOREM·DVCEMQVE·HOSTIVM·IN
TRA·MOENIA·ATQVE·ADEO·IN·SENATV·VIDEMVS·INTES
TINAM·ALIQVAM·COTIDIE·PERNICIEM·REI·PVBLICAE
MOLIENTEM·SI·TE·IAM·CATILINA·COMPREHENDI·SI
INTERFICI·IVSSERO·CREDO·ERIT·VERENDVM·MIHI·NE

ANNO DOMINI 1485. QVO VSQVE TANDEM ABVTERE Catilina, patientia nostra? Quam diu etiam furor iste tuus nos eludet? Quem ad finem sese effrenata iactabit audacia? Nihilne te nocturnum praesidium Palati, nihil urbis vigiliae, nihil timor populi, nihil concursus bonorum omnium, nihil hic munitissimus habendi senatus locus, nihil horum ora voltusque moverunt? Patere tua consilia non sentis? constrictam iam horum omnium conscientia teneri coniurationem tuam non vides? Quid proxima, quid superiore nocte egeris, ubi fueris, quos convocaveris, quid consili ceperis, quem nostrum ignorare arbitraris?

O tempora! o mores! Senatus hoc intellegit, consul videt: hic tamen vivit. Vivit? immo vero etiam in senatum venit, fit publici consili particeps, notat & designat oculis ad caedem unum quemque nostrum. Nos autem, fortes viri, satisfacere reipublicae videmur, si istius furorem ac tela vitemus. Ad mortem te, Catilina, duci iussu consulis iam pridem oportebat, in te conferri pestem quam tu in nos iam diu machinaris. An vero vir amplissimus, P. Scipio, pontifex maximus, Tiberium Gracchum mediocriter labefactantem statum reipublicae privatus interfecit: Catilinam, orbem terrae caede atque incendiis vastare cupientem, nos consules perferemus? Nam illa nimis antiqua praetereo, quod C. Servilius Ahala Sp. Maelium novis rebus studentem manu sua occidit. Fuit, fuit ista quondam in hac re publica virtus, ut viri fortes acrioribus supplicis civem perniciosum quam acerbissimum hostem coercerent. Habemus senatus consultum in te, Catilina, vehemens et grave. Non deest rei publicae consilium, neque auctoritas huius ordinis: nos, nos, dico aperte, consules desumus.

Decrevit quondam senatus, ut L. Opimius consul videret ne quid res publica detrimenti caperet. Nox nulla intercessit: interfectus est propter quasdam seditionum suspiciones Caius Gracchus, clarissimo patre, avo, maioribus, occisus est cum liberis M. Fulvius consularis. Simili senatus consulto C. Mario & L. Valerio consulibus est permissa res publica: num unum diem postea L. Saturninum tribunum plebis

M.I.T. Photo

Reduced facsimile of a specimen page showing the type designed and made by Dard Hunter, Jr.

Patrons for this very interesting event were President and Mrs. Karl T. Compton, Dr. and Mrs. Harlow Shapley, Mr. and Mrs. Milton E. Lord, William S. Newell, '99, and Mrs. Newell, Mr. and Mrs. Carl T. Keller, Edwin S. Webster, '88, and Mrs. Webster, William H. Coburn, '11, and Mrs. Coburn, and Raymond Stevens, '17, and Mrs. Stevens.

The pourers at the tea, which was attended by more than three hundred guests of the Friends of the Library, were Mrs. Alvan T. Fuller, Mrs. Gardiner H. Fiske, Mrs. Charles E. Bacon, Mrs. A. Farwell Bemis, Mrs. Coburn, Mrs. Compton, Mrs. Robert Cushman, Mrs. Lewis Davis, Mrs. Malcolm B. French, Mrs. Frederic R. Galacar, Mrs. Joel E. Goldthwait, Mrs. J. Rhyne Killian, Mrs. Eugene C. Hultman, Mrs. Harold F. Kellogg, Mrs. Stevens, and Miss Virginia Stone.

An exhibition of special interest shown in the rotunda of the Rogers Building is a collection of delicately executed ivory panels carved by Brainerd B. Thresher of Cincinnati, whose son, B. Alden Thresher, '20, is director of admissions at the Institute. Most of these beautiful carvings were exhibited in 1939 in the Palazzo Antici-Mattei in Rome, and in Florence and Venice, under the auspices of the Centro-Italiano di Americani. Mr. Thresher's work reveals a combination of Greek and Oriental influence.

Toward a Philosophy

THE letter which follows, written by an Institute alumnus father to an Institute undergraduate son, is commentary on our times which The Review believes will be of interest and stimulation to other Alumni:

Dear Dan: Your letter, in pessimistic mood, has been received. I am glad that you wrote me thus, glad to have an insight into some of your doubts and uncertainties. You say that the world is cockeyed. You are impressed with the maladjustments of its economic life — the want, the unemployment, the labor strife. In the contemplative quiet of your college life you shrink from the thought of war and conflict.

I am not worried about you. These are perfectly normal doubts, and I can recall quite similar moods of protest on my own part. It is not an easy problem to find yourself and your task in life. And, though you underestimate your own ability, I would rather have you modest in that respect than too cocky.

But, while it may be perfectly natural to entertain these questions and doubts, it would be fatal to let them dominate you. Courage does not consist in *not* being afraid, but rather in conquering fear. So you must conquer these doubts.

It *is* a cockeyed world, Dan — though perhaps no more so than it has always been. Certainly it seems to be a less secure world than it was twenty-five years ago. Change — tempestuous and untamed — is in the saddle. However, it is perhaps a healthy change. In the very turmoil of our democracy an aspiration, an aiming point, is expressed. In Vincent Sheean's novel *Sanfelice* the most striking line seemed to me this: "The Revolution . . . is eternal: it is the lifting of more and more people to the surface of life; it is the one continuous movement of mankind, and there has never been, and likely will never be, any other." Lifting more people to the surface of life — perhaps that is a good summary of the underlying principle of change, of human aspiration, of progress — if we can believe that the world is progressing a bit from age to age. If only we can steer this change by means of peaceful evolution, not violent revolution!

Get hold, if and when you can, of some significant purpose in life, some aiming point which you can sight on for the long pull. In other words, go somewhere as hard as ever you can. It is well if a man finds such a purpose early, as it brings meaning and steadfastness to his life. But the goal may well be slow in the finding and yet all the clearer and more compelling later on.

Such a purpose, just for example, came to —— ——. A young teacher of economics, he was called to arbitrate a strike of agricultural laborers and found, as he said, that his textbook theories taught him nothing of the motives which animated those strikers. So he started over again to educate himself, in America and in Europe, working in psychology, in the social sciences, in human nature. Later, in the World War and up to his early death, by virtue of his preparation and with his insight and fairness he performed a very valuable service in helping to settle the extensive strikes in the great lumbering industry of the Northwest. I believe that had he lived he would have made a material contribution to what might be termed the art of human relationships — an art never more needed than today. Engineering, which you are studying, has to do with shaping the forces of nature to man's will. But a greater task is to understand and shape the forces of *human* nature — and to shape them, if it may be, by peaceful means.

And yet it's no good, Dan, to shrink from the thought of war and strife. As Oliver Wendell Holmes once said, the struggle for life is the order of the world, at which it is vain to repine. Man's destiny has been to fight. I have seen war's horrors; I hope you may escape them. But if war comes to our country, I would not have you away from it. And if we happily escape war, some teacher of the sort we still need, that we may not be smug, soft, comfortable — that we may be ready for danger.

My own philosophy of life has been boiled down to the point where the principal word in it is *courage*. Add to courage *fairness*, and you have, it seems to me, the two basic qualities of character, which all men admire. If there is one thought that I try to put over to your kid brother, it is the hope that he may be brave and square.

I have said that the world seemed less secure than formerly. Perhaps in the past we have stressed too much the factors of safety, security, permanence. Life, to be significant, must be something of an adventure. But adventure means risk; you can't play safe and have your adventure too. Perhaps only by a fearless acceptance of change and a stern preparation of our bodies and souls to meet it can we hope to abide the adventure successfully.

And last, I know that you, with something of your mother's sensitivity, will not fail to look for beauty along the way. Living is an art, and the search for truth and beauty will do much to enrich life.

I have every confidence, Dan, in your capacity for facing the adventure of life bravely and lightheartedly. Devotedly, Dad.

Five years ago at Saybrook, Conn., M.I.T. '16 met at its twentieth reunion, depicted here as reminder and as foretaste of the quarter-century gathering scheduled for Osterville, Mass., June.

EXIT

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Curare, in the jungle, is made only by those who are well versed in the ancient lore.

Courtesy Henry Holt and Company

THE GENIE IN THE AMPOULE

(*Continued from page 298*)

fundamentals of primitive procedure. The jungle secrets of curare making have always been carefully guarded by the curare makers, who were, in the main, the tribal witch doctors, a brotherhood valuing keenly the psychological effects of awe and mystery surrounding their craft. Consequently, through primitive contacts arduously built up and maintained, we had to penetrate behind the curtains of witchcraft and general hocus-pocus in order to ferret out the grains of pharmaceutical truth which lay there.

Apart from the witchcraft side of things, the jungle end of the work was further complicated by the fact that the curare makers, whose only interest was to produce a death-dealing substance, frequently introduced into their "standard recipes" varying amounts of extraneous toxins, venoms, or even puzzling inerts for ritualistic or lethal purposes. Hence one witch doctor would not necessarily duplicate his curare with precision each time he made it. Finally, add the fact that throughout every one of the known curare-producing regions in South America the technique and ingredients differ widely from witch doctor to witch doctor, from tribe to tribe, from region to region, and you can understand why the production of a predictable curare has presented overwhelming difficulties.

The history of the clinical use of curare was much more helpful and accurate, although until quite recently it presented a record of only mediocre success. Even the clinical results were, however, somewhat dubious, as a result not only of the variation but also of the smallness of each batch of curare. These factors meant that there was never at any single time enough of any one batch of the drug to enable biological standardization, that there was simply not enough curare available to the world for the carrying on of sustained work.

The terminal physiologic action of curare had long been known. The attempt to use curare clinically dates back to 1857, when its specific effect was discovered by the French physiologist Claude Bernard. The effect of the drug when injected under the skin of an animal seems to be directed selectively against the myoneural junctions of the motor end plates, an action which is measurable, in sublethal doses, in the ratio of the weight of the drug used with the weight of the animal in which it is used. The drug's action, as has been said, leads to relaxation of the striated, or voluntary, muscles, because of the partial severance of the myoneural junction. The severance, in turn, is established by the abolition, to a certain degree, of acetylcholine, the chemical "mediator" which transfers or conducts motor impulses from nerves to the muscles at the myoneural junction.

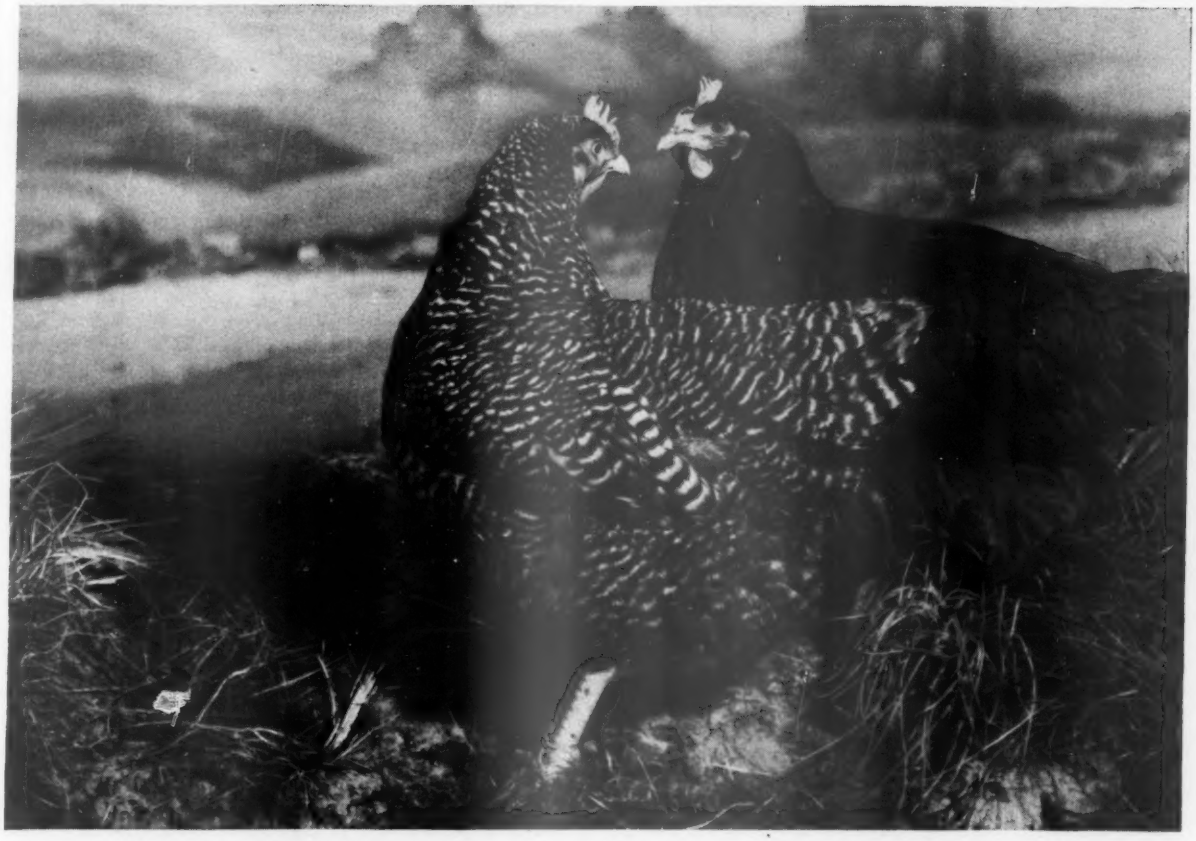
Used primitively, or carried to a laboratory extreme, relaxation may become complete, death supervening with the cessation of nerve impulses to the respiratory organs and eventual heart failure. Theoretically, and now actually, in clinical use the extent of relaxation can be controlled because of the predictable relation between the amount of the drug used — dosage depends on body weight and other variables — and the effect on the motor end plates.

Curare (granted a *predictable* supply) can be used to therapeutic advantage in many diseases involving a state of muscular hyperinnervation, as in spastic paralysis, and indeed has already been so tried with gratifying results. The same effect is desirable also when a state of conscious immobility is necessary, a fact which is the basis of the now successful and recognized use of curare in the shock-therapy method of treating certain mental diseases.

In addition to the problems relating to the production of the drug per se, we were faced with the definite *clinical* requisite of evolving a curare which would not give rise to unwanted side reactions, such as certain toxic states, urticaria, and so on, or act upon the junctions of the phrenic nerve and thereby cause respiratory failure upon administration. It was therefore necessary to evolve a curare not only capable of a sustained lissive, or relaxing, action but so peculiarly and highly selective that respiratory embarrassment could be predictably eliminated. Our work, both in the field and in the laboratories of civilization, was necessarily aimed at this objective as well as at all the other aspects essential to the production of a functional curare.

This article is hardly the vehicle for a detailed exposition of the long months of jungle work which went into the present curare or for explanation of how a technique of field research was gradually evolved out of years of previous jungle experiences and primitive contacts. In any event, the work was successfully brought to its present stage on our most recent South American expedition, which, in itself, was quite a party. When, after months of preparation, it was in the field, the expedition successively involved, in addition to a complete "top" personnel, thirty mules and six riding animals; seventy-five Indian porters with four subchieftains to look after them; a fleet of twelve dugouts, each canoe with its own crew of men; and an adequately housed expeditionary base, set up so as to include a complete field laboratory among hundreds of other articles of necessary equipment. Much of the success of the expedition was owing not only to the generous co-operation of the government of Ecuador, in which country our work was accomplished, but also to the friendship and warm understanding of His Excellency, Colón Eloy Alfaro, Ambassador of Ecuador to the United States.

(*Concluded on page 318*)



"What's a Road For?"

FOR a chicken a road is an obstacle to be crossed, but for a man it is a means for overcoming the obstacles of time and distance that tie him to one spot.

It is no accident that the roads that crisscross America form the greatest highway system in the world, that they carry more vehicles than those of any other nation. The roads are there because Americans are an adventurous people, seeking distant horizons and far places. They are there because America is a great continent with distances spanning one-eighth of the globe. They are there because no American is content to *be* less, to *do* less, to *have* less, for himself or for his family, than any other man.

But none of these things alone could have built those millions of miles of roads nor have put millions of automobiles upon them. The roads and the automobiles are there because American industry, interpreting the needs of a people and giving them shape and form, made possible roads that the people could afford to build and maintain, automobiles that the people could afford to buy and run.

For more than 60 years General Electric engineers, scientists, and workmen have helped American industry to satisfy the needs of this restless, robust, growing, active America. In creating More Goods for More People at Less Cost, they have made the dreams of fathers and mothers come true for America's sons and daughters. America lives better, through better things for living. General Electric Company, Schenectady, New York.

G-E research and engineering have saved the public from ten to one hundred dollars for every dollar they have earned for General Electric

GENERAL ELECTRIC

952-119C-211

The making of curare is steeped with superstition and jungle ritual.

Courtesy Henry Holt and Company

THE GENIE IN THE AMPOULE

(*Concluded from page 316*)

The field work and the subsequent feverish stimulation of laboratory and clinical research are, after all, only part of the story of curare. Much pharmacological and clinical research and experimentation were necessary before the drug could ever be medically functional. For that vital part of the work, credit is owing to the widespread and exceedingly generous research efforts of a large number of institutions and men. Among the former, I should like to mention especially E. R. Squibb and Sons, who were willing to take what might be called a long chance on a drug which was half medical speculation and half a traveler's tall tale. Among the individuals were Dr. Walter Freeman of Washington, D. C., who first discussed with us the problem of curare and expressed his willingness to become a curare pioneer if we could solve the jungle end of things; Dr. Michael S. Burman of New York City, who, though his work was done before the advent of our curare, first successfully demonstrated and published the use of curare in the field of spastic paralysis; and Dr. Archibald R. McIntyre, chairman of the department of physiology and pharmacology of the University of Nebraska's college of medicine. In co-operation with E. R. Squibb and Sons, Dr. McIntyre performed a unique labor in establishing an adequate knowledge of the pharmacology of the erstwhile arrow poison.

The outstanding pioneer in the new curare work is Dr. A. E. Bennett, also of Nebraska, whose research and clinical practice have made possible the employment of curare in what is today its greatest and most widespread field of usefulness: the treatment of mental diseases. Curare can now be said to have salvaged shock therapy when it was about to be entirely abandoned because of the resulting dangers of grave trauma and to have remade this therapy into one of the most useful in psychiatry — a fact recognized when Dr. Bennett's work received a certificate of merit from the American Medical Association last year.*

Thus it appears that still another predictable genie in an ampoule has been given to medicine — a genie which issues forth in the unimpressive form of a few cubic centimeters of light amber fluid but which in the field of mental diseases miraculously produces something of greater worth than the legendary treasures of the genie of old: restoration of sanity and normal lives. Upon completion of further field work, which we hope will be accomplished shortly, we are now certain that this same genie of the jungles, still further tamed and even more predictable, will accomplish comparable miracles in other equally important fields of medicine.

* For a more detailed story of curare as well as further credits due the various workers in it, see Richard C. Gill, *White Water and Black Magic* (New York: Holt, 1940).

A PILE DRIVER'S RESPECTS

(*Continued from page 306*)

who are their associates. We are frequently put to it to match such knowledge with our own contribution in the form of years of active experience. If the professors will concede that the definition of "scientific knowledge" does not embrace how to snake a timber pile off the cars and get it into the ground, then we may repeat our phrase in the generalization: Everybody is still happy.

To offset our admission of delinquency in scholastic matters, however, we have still to present a few ideas on engineering education. Let us make use of the analogy of modern highway traffic and affirm what we think should be good construction and traffic rules for the high-speed artery of engineering education. Presumably, like our vehicular highway system, this educational artery is still under construction — curves are being eased, grades improved, and the like. We may assume that for safe educational traffic in the state of pedagogy there are standards of construction and operation comparable to the fine highway regulations of such states as Massachusetts, Pennsylvania, and Wisconsin. Let us speculate a little on these rules. We may expect to become either the beneficiaries or victims of the skill or unproficiency of those who set up the rules.

A minimum number of stop lights are undoubtedly planned, and cloverleaves and bridges will be plentiful. Thus the student bent on pure theory need not be held up by the left turns of those desiring to enter the lanes of "practical subjects" on the way. Or, bluntly, don't put too many practical subjects on the required list.

Brain knocks of impracticality on the part of the student will be carefully noted by the professorial driver. For the proper corrective gas, such students must be detoured promptly into one of the practical lanes. Or, bluntly again, you professors have a man-size job to keep a true balance between the theoretical and the practical. The measured-mile stretches which you lay out for the educational highway must register student brain velocities as divergent as the five-ton Mack and the streamlined Packard.

"Pile-driving Foreman Has Right of Way" will be on one of the many warning signs of the highway. Just a little tip to the professor that it is meet to render unto Caesar the things that are Caesar's, and to leave to the pile-driving virtuoso some of the more elementary aspects of the subject.

"New Construction Ahead" signs will warn the driver that he must go slow in localities where advancing industrial practices may soon require revision of class-

room theories. Don't teach the boy too many things to be unlearned later. Upon leaving the classroom for the factory, he becomes a modern exemplar of Galileo. Often he must try to adjust scientific formulas to manufacturing processes that have been going on for generations. Let his training imbue him with such deep reverence for the laws of pure science that he will stay with the occasional problem on which, apparently, science and practice fail to agree. Modern Galileos are reconciling such discrepancies, to the eternal credit of their instructors and to the benefit of both science and practice. Therefore let the rules of our highway quickly take away the license of the student driver who shows a tendency to accept too complacently the so-called practical solution which seems at variance with theory. Such a practical boy is headed for a smashup on some future road where the traffic is too fast for his sluggish reactions. Do him the favor of taking him off the road now.

"Slippery When Wet" signs will be for stretches where the instructor who thinks he is something more than a teacher holds forth. We recall two such gentlemen of twenty-five years ago: a classroom humorist and another so deeply engrossed in astronomical vagaries that a student had to be sharp to cull a few scientific nuggets from a matrix of pseudo humor or, sometimes, pure speculation. The instructor must remember that the student drivers are taking the rules very seriously; he shouldn't let them down.

Signs reading "Thickly Settled" will, presumably, be prominent in some sections. The metaphor becomes slightly mixed at this point, but the intent is that the student should be warned to restrain his ardor for exposition when he meets other drivers who, while not carrying on with full benefit of clergy, are nevertheless good, safe drivers — men who are getting reasonably satisfactory answers, that is. Tolerance for the opinions of others is important.

Brake-testing stations, of course, should appear frequently. The student will appreciate good brakes when he leaves the well-policed campus and meets the less predictable cops on the roads where he is to practice his profession. He will encounter many poorly lighted streets, and will have to make many quick stops and pauses to consult the maps he has with him from the last academic filling station.

Humanity demands many refreshment stations on the educational highway. Such stations will be under strict orders (with capital punishment prescribed for those who fail to comply) to serve man-sized portions of good old corned-beef-and-cabbage arithmetic, that the superiors under whom the student will later serve may rise to bless the cooks thereof. *Ut ameris amabilis esto.* Major portions of well-done English, well sauced with palatable punctuation, will be featured, and the general menu will be designed to maintain good digestive functions of expression. (*Concluded on page 320*)

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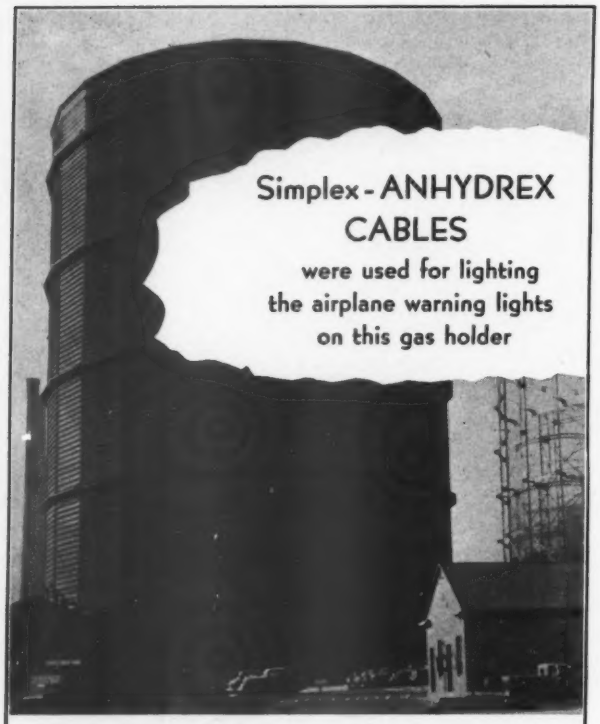
The Catalogue contains full information and will be sent gratis and post free upon request. All correspondence regarding admission either to undergraduate or graduate study should be addressed to the Director of Admissions, M.I.T., Cambridge, Mass.



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A PILE DRIVER'S RESPECTS

(*Concluded from page 319*)

The foregoing somewhat superficial counsels, which we might easily extend, are from the outside-looking-in point of view and would have greater value if flavored with a more intimate knowledge of the inside point of view. The lazy alumnus, of course, will say that this lack is the fault of the professors. They should broadcast their methods and aims more widely if they want more valid advice from the outside.

The colleges are trying hard to do so. But they must try harder. It is amazing, the integumentary thickness of resistant notions that twenty-five years of practice accumulate on engineering skulls that aren't so empty once you get through to them. You in the schools must concoct prescriptions which have more penetrative power. More news instinct in your broadcasts and more reader interest in your texts are other ways of putting it.

We see one example of this necessity in our popular technical journals, where job stories read in page units, as against modest post-card notices for scholastic aims and accomplishments, usually. Cause and effect are thus out of balance in the publicity of our profession. The completed job — the effect — is set forth in dramatic style, while the training back of the job — the cause — gets a brief notice that is apt to be fully as dramatic as the bill of lading for a crate of eggs. Let's agree that drama is not incompatible with professional dignity. Such drama is more difficult of attainment, true; but one of the things young engineers soon learn is that the degree of accomplishment is measured by the difficulties in the way.

Extremely hard, it must be, to keep curricula in step with advancing engineering science and to maintain the true balance necessary between purely scientific subjects and those dealing with their practical applications. More power to you professors in your endeavors to solve this difficult problem successfully. Perhaps the practicing engineer can offer some help. After all, we have something in common with you. We drive timber piles and the like into mother earth; you drive ideas into young men's skulls in order that they may make a living by doing things to mother earth and her elements.

Perhaps you pedagogues and we pile drivers can get together.

SUBLICARIIS ALIISQUE

(*Continued from page 307*)

mixed up with this plan, I believe it to be the best. Not that I think all other methods should be abolished and all students put on the co-operative basis. I clearly recognize the good points of other plans and appreciate that to meet the aims and needs of all students, all effective methods should be employed. My purpose here, however, is to present the educational principles and procedures of the co-operative plan, and I'm going to stick to that job.

In 1906, Herman Schneider instituted at the college of engineering of the University of Cincinnati the co-operative plan of engineering education, whereby students alternate periods of study at school with peri-

ods of experience in industrial plants. It is significant that this modern educational procedure was conceived and first put into operation in an engineering school. Only in comparatively recent years has the plan been applied to colleges of liberal arts. At M.I.T., six Departments are now conducting Co-operative Courses, those in Electrical Engineering having been in operation over twenty years. Many practical operating difficulties have had to be worked out, and at the present time a highly effective plan of operation has been developed, which makes each period of a Course of the maximum educational value, whether the student is at the school or at the plant of a co-operating company.

In the first place — and this point is fundamental — the co-operating companies recognize that industry shares an equal responsibility with the engineering schools in educating and training the recruits to its engineering force. Hence M.I.T. Co-operative Courses are not of the earn-while-you-learn variety. To be sure, the students earn wages and are paid wages, but the money earned is a mere by-product of the plan.

In the second place, note how each detail has been worked out entirely on the educational principle of making each period of the greatest possible educational value in preparing the students to understand clearly the industrial problems of their own era and equipping them to contribute to the solution of these problems.

In the third place, consider the detail of the length of the co-operating periods. If they are too short, a student cannot undertake a job of major importance, because such a job usually requires several months for completion. If the periods are too long, the student remains away from school so long that he gets out of the habit of study and loses considerable time in taking up the slack. The Co-operative Courses in Electrical Engineering and in Mechanical Engineering at Technology have standardized the "term-on, term-off" schedule for the following reasons:

(1) To make the periods spent at the Institute coincide with the regular Institute terms. The student thus becomes a part of the regular student body and is afforded an opportunity to enter into the regular campus activities. Experience has shown that the percentage of co-operative students engaged in important extracurricular activities is as high as that of students in the nonco-operative courses.

(2) To afford a four-month work period, which enables the student to be put on more important projects and to advance through the various stages of responsibility connected with them. On special assignments the period may be lengthened to eight months.

The student's habit of study is maintained while he is at work by his having to carry on regular classwork in the engineering subject which he would have been pursuing had he remained at the Institute. In general, the nonresident courses are conducted by engineers of the co-operating companies and have proved unusually effective. The instructors not only know the theory of the subject but also are able to point out numerous applications that are being carried on in the local plant right under the student's eyes. With two evenings a week taken up by recitations and two evenings by preparation, the student keeps (*Continued on page 322*)

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SUBLICARIIS ALIISQUE

(*Continued from page 321*)

up his study habits and still has three evenings a week for recreation. An experience of twenty years has proved that periods of intense mental activity alternated with periods of less intense study are surprisingly effective in developing mental powers, just as periods of intense physical exercise alternating with periods of lighter exercise (not complete rest) have proved the most effective routine for producing maximum physical fitness. This result is to be expected, and it is a matter of fact that toward the end of a term spent in intense study at the Institute, the student begins to look forward to the practical work at the plant. And after a term spent at the plant, he is just as anxious to get back to his studies at the Institute.

One outstanding need of American industry is for off-standard engineers. Industry does not want its engineers to be human bricks, just so long, so wide, and so high. All engineers must of course be trained to think with the same rigor. All must be thoroughly grounded in the same fundamental mathematics, physics, and economics. But, in addition, industry desires that each engineer should have some particular field in which he shows a marked aptitude and in which he has more than the usual knowledge common to all graduates. The Institute's Co-operative Courses, containing, as they do, the same basic scientific and economic principles and differing only in the specific applications of these principles, easily meet the first two requirements. And they go farther, because of the realization that arrangements must be made elastic to meet the need of the individual student. In all save the basic subjects, therefore, substitutions are not only allowed but encouraged. This provision does not mean that a student can scatter all over the lot, but rather that in the later years of his course he is encouraged to select his subjects of study for the purpose of arriving at some particular goal in some particular field where he is ambitious to work and for which his natural aptitudes fit him. Obviously, the extent to which such a policy can be pursued is limited by the size of the school and by the number of subjects it can offer.

This same educational principle is applied to the work at the plants. A plan of co-ordinated practice and study has been worked out in which the engineering practice constitutes regular courses, just as carefully laid out and supervised as the courses of study at the Institute. Moreover, just as at the Institute no two

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students need be taking exactly the same studies, so at the plant no two students need be working on just the same projects. A group of projects is first laid out which every student takes in order to secure an adequate knowledge of fundamental operations. Later the individual student is assigned to those special projects which will advance him most surely and quickly toward the goal at which he is aiming. The projects which make up a student's practical experience are arranged in rising order of importance and difficulty.

In order to establish and maintain proper co-ordination of studies and practice and to insure that the practice proceeds by steps requiring increasing technical knowledge and skill and more responsibility on the student's part, the student receives his industrial experience in the plants of one company only. Each company must therefore be of a size sufficient to offer the student a comprehensive experience in his chosen field. A student in the Electrical Engineering Co-operative Course, for example, receives his industrial practice with the General Electric Company, the American Telephone and Telegraph Company, the General Radio Company, the Boston Elevated Railway, or the Boston Edison Company. In the Mechanical Engineering Co-operative Course a student is with either the General Electric Company or the Boston Edison Company. An added advantage of the arrangement is that a young engineer comes to understand the company's policy and gets acquainted with the personnel. Thus he acquires a certain company loyalty — an all-important quality in the education of any young man.

Expressed in educational vernacular, the educational value of the intimate contact that the student has with industry develops not only in his learning how physical laws and theories are applied in practice but also in his dealings with workers and managers. Such contact acquaints him with the everyday applications of his studies in psychology, human relations, business law, and organization. It humanizes his humanistic studies as no amount of book learning could do. It fits him earlier to assume positions of responsibility, where judgment and the knowledge of how to handle men are important. Furthermore, he doesn't have to learn from costly experiences, after he is out of college, that, in engineering, every equation has a dollar sign attached to it and always contains a term representing the human element — two vital quantities often neglected in problems required in school. (*Concluded on page 324*)

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SUBLICARIIS ALIISQUE

(*Concluded from page 323*)

For concrete evidence, let's look at the record. *The graduates report thus:* Learned what kind of work I liked. . . . Found out several kinds of jobs I didn't want. . . . Was able to judge merits and demerits of employment offers. *The students report thus:* Learned what an engineer does. . . . Learned to get along with all kinds of people. . . . Found out I didn't need much theory on any particular job, but what I did need, I needed mighty badly. . . . Learned that what I got out of a job didn't depend upon the kind of job but on what I put into the job. . . . The practical knowledge I have gained in this time amazes me. It is something no amount of classroom or laboratory work can teach. *The co-operating companies report thus*: Even during depressions we never discharged or laid off any graduate whom we had hired from this Course. . . . We had more than a year's experience with each student before we hired him. . . . Graduates in company's employ make unusually rapid progress. . . . The close contact with the Institute is of great benefit to our staff. *The members of the Faculty report thus:* We enjoy teaching classes of these students. . . .They are more alive, take a more comprehensive view of a subject, and have a real earnestness of purpose. . . . The close contact with the co-operating companies keeps us informed on what is going on in industry.

And, lastly, one observation on our educational philosophy in the large: From the great importance of Institute research, one might conclude that research and the training of expert investigators are the primary purposes of the Institute. Not so. The chief value of research at the Institute is its educational value — the inspiration which it gives to thousands of undergraduates working side by side with talented scholars engaged in pushing out the boundaries of human knowledge. This is another fact that emphasizes the all-important problem of establishing more effective communication between the Institute and its Alumni. In this whole enterprise we need and seek the advice and assistance of every pile-driving son of the Institute.

"THEM AS HAS, GITS"

(*Continued from page 303*)

speed, it has long been the custom to lead air to a radiator through a duct, which slows the air down. After passing through the radiator and having its temperature raised, the air can then be released at increased speed to the atmosphere. Hence the external ducted radiator often seen under a liquid-cooled engine nacelle. At present the thrust so obtained is sufficient to neutralize perhaps a large part of the drag created by radiator and duct, but whatever the gain, it is virtually pure profit.

Since a duct of the proper shape can be designed much more easily for the unit radiator of a liquid-cooled engine than for the numerous cylinders of one cooled by air, planes employing the former type of power plant have so far benefited most from the radiator propulsive effect. On the other hand, the efficiency of a radiator and nozzle when used as a heat engine in this manner should increase with the temperature of the radiator surfaces, and the fins of an air-cooled cylinder are much hotter than the tubes of a liquid-type radiator.

Prediction is that, as speeds increase, the thrust from the radiator may not only neutralize radiator drag but may, conceivably, contribute slightly to the forward movement of the plane. Novel as it may sound, the idea of a radiator pushing a plane is of a piece with the far more drastic but often heard proposal to drive airplanes entirely by jets, i.e., to make rocket ships out of them. Regrettably, the cloud of fantasy which surrounds this subject is apt to hide the facts that rockets of one sort or another are almost as old as gunpowder, that in tests during 1935, rockets weighing from sixty to eighty pounds reached speeds of 700 miles an hour and altitudes of 14,000 feet, and that a great deal of serious investigation has only emphasized the soundness of the principles involved.

Difficulties being encountered at today's speeds center mostly about the propeller and are already causing many aeronautical engineers to consider the use of jets as the main propulsive means. As long as the propeller surfaces, always moving much faster than the plane, can stay below the speed of sound, they are highly efficient,

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converting into thrust about 85 per cent of the power delivered by the motor. But propellers, sharply limited in diameter and in the number of blades they may have, are already beginning to have trouble absorbing the great amounts of power which present engines can produce. During take-off and — with fast pursuit ships — during flight, propeller tips are frequently traveling nearly as fast as sound. At that speed, moving objects build up a compression wave which creates a comparatively enormous increase in drag. If airplane speeds continue their penetration of the fourth hundred, these compression waves will creep farther down the propeller blades, causing such drastic decreases in efficiency that other propelling means will have to be considered.

Then Buck Rogers may very well turn out to have the right idea. But the as yet speculative rocket planes will differ sharply from present rockets in at least one respect: They will probably continue to use gasoline as a fuel, since this liquid has several times the energy per pound of any explosive and carries with it all the elements required for its disintegration. In order to release the energy contained in the hydrocarbon, however, three and a half pounds of oxygen per pound of gasoline are required. Rocketers now supply this oxygen in liquid form, a practice which is prohibitive from the standpoint of weight and safety unless they wish to adventure in regions beyond the earth's atmosphere. Prosaic aviators, swishing along at 500 miles an hour, apparently an attainable speed as far as present airplane shapes are concerned, will pick up and compress their oxygen as they go along. To do so will require equipment and power; consequently, results will fall considerably short of the dazzling horsepower-to-weight ratios obtainable from rocket motors employing liquid oxygen.

DESTROYERS

(*Continued from page 301*)

of a destroyer is estimated at three minutes. That's a total of six minutes. She will cost six million. That's a million a minute. Well, in his opinion, she is up to it — except for such and such particulars. These form the basis of the present argument, which goes on interminably, back and forth, while the destroyer roars over an azure sea, going all one way. She knows nothing of the arguments and nothing of her possible weaknesses.

The technicians are talking about balance, but they do not use the word in its easy and familiar meaning. Balance is a technical thing. The destroyer's wheels have so little whip to them that standing on the deck forward is like standing on a street corner. There's no vibration at all. A hen could lay an egg there, or at least wouldn't be afraid to try. This is mechanical balance.

Strange irony. We know, it seems, everything about balance in this unbalanced world. We know everything and understand nothing. Our tools are precision tools at the same time that our thinking, in all ways not strictly scientific, is not precision thinking. We are like a man who should make the discovery of the age — and then goes out and makes a fool of himself with a woman. Technically, we seem to be almost with the high gods. Emotionally, we are (*Concluded on page 326*)

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DESTROYERS

(*Concluded from page 325*)

not much better than the Cro-Magnon cave man. The destroyer's performance can be predicted almost to a hair by the men who build her, but the performance of the ship of state is not so easily predictable. Our ship of state is more than one hundred and fifty years old and still must be rebuilt with almost every breath we draw. Rebuilt, too, almost at a venture, because its peculiar balances have been so little calculated.

Is that because any given man of us has so small a part of her for his charge? But the destroyer has got herself born by the labor of farm hands and clam diggers, simple men who know but a part of the deadly contrivance they have created. True, they know that part effectively. Their character has gone into her. Nevertheless their work, mysterious and godlike as it is, can be destroyed in a twinkling. The destroyer is a lethal force, but she is also a weakling. The fault of a seasick navigator can send her to the bottom. So can one five-inch shell in her gizzard. Perhaps our ship of state can learn something from destroyers.

THE TABULAR VIEW

(*Concluded from page 282*)

ber. Now he brings a group of old-time craftsmen themselves (page 304) as they were depicted nearly six centuries ago.

On 'Change. — The M.I.T. has many good fortunes, none among which is of more lasting value than the fact that wherever and whenever Alumni and staff meet, whether two are lunching together or hundreds are assembled in some kind of conclave, discussion soon centers on the perennial topic of educational philosophy and its crystallization. In no small measure has the vitality of the Institute as a unique educational center been fostered and enhanced by this condition. That the uses of technological and scientific education are so direct and measurable is, perhaps, one main reason why such discussion flourishes year by year; professor and practitioner alike have a pragmatic as well as philosophical problem at heart. One phase thereof is ably considered in this issue of The Review (page 306 and 307) by EDWARD H. CAMERON, '13, a public utilities engineer whose career has included many other fields, and by WILLIAM H. TIMBIE, Professor of Electrical Engineering and Industrial Practice at Technology. Writing from the point of view of an engineer of broad and distinguished experience, Mr. Cameron stresses the need for practical grounding as well as theoretical training in the work of the engineering student. Commenting from the point of view of an educator of varied and notable record, Professor Timbie describes one highly effective means of meeting that need.

Integument. — To the Cover Club comes CARL A. SEGERSTROM, JR., '39, with a photograph of apt title — "And 'Y' Comes after 'G'" — plus fit nostalgic atmosphere.

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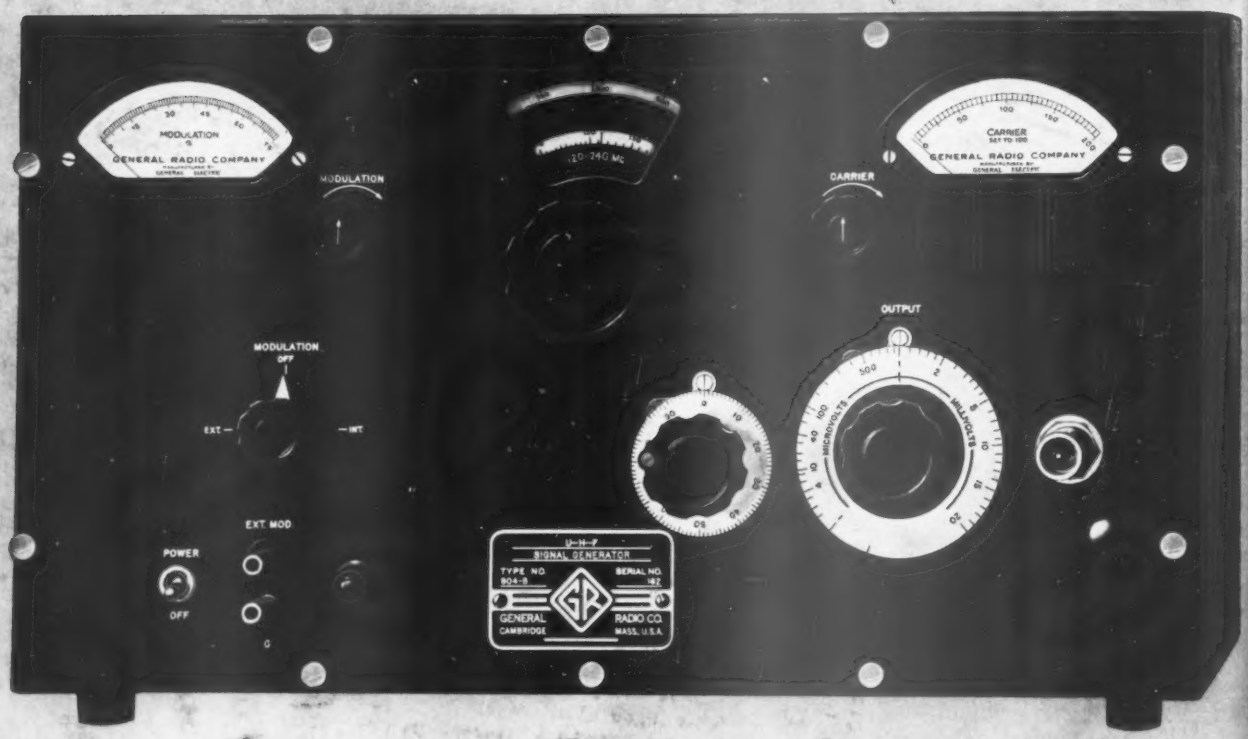

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- **THOROUGH R-F SHIELDING** — leakage cannot be noticed on any available receiver — no openings in panel or cabinet — panel voltmeters and all dials shielded
- **OUTPUT VOLTAGE CONTINUOUSLY ADJUSTABLE** — from 1 microvolt to 20 millivolts up to 100 Mc; 10 millivolts to 330 Mc
- **CAPACITIVE VOLTAGE-DIVIDER ATTENUATOR** — carrier frequency cannot change with attenuator setting
- **ATTENUATOR DIAL DIRECT READING** — in microvolts and millivolts — slow-motion gear drive for ease in setting
- **CONCENTRIC SHIELDED OUTPUT CABLE** — with a 75 ohm characteristic impedance furnished with each generator
- **MODULATION CONTINUOUSLY ADJUSTABLE** — 0 to 60% with amplitude modulation — external modulation characteristic is flat within 2 db from 100 to 20,000 cycles
- **BUILT-IN VOLTAGE REGULATOR** — effectively eliminates difficulties due to fluctuating line voltage

Type 804-B Ultra-High-Frequency Signal Generator.....$350.00

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